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ELECTRONICS AND ELECTRICAL ENGINEERING

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USSR REPORT

ELECTRONICS AND ELECTRICAL ENGINEERING

No. 120

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UDC 621.318.5:621.395.65

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Moscow ELEKTROSVYAZ' in Russian No 8, Aug 83 (manuscript received 12 May 82) pp 40-43

TUMANYAN, L. A.

[Abstract] The parameters of contact and noncontact switching devices are compared and the outlook for their use in space switching systems is determined. The principal indices involved in this outlook are described. The advantage of contact devices over noncontact analogs is shown to be the absence of potential connection of the control and load circuits. An analysis is made of the reliability characteristics of the semiconductor devices and circuits involved. One of the requirements imposed on systems of space switching is their generality with respect to transfer of analog and discrete information. Creation of universal systems of space switching on a noncontact element base is as yet difficult and requires a particular expenditure on conversion of analog signals. References 14: 11 Russian, 3 Western.
[30-6415]

UDC 621.315.212

RECOMMENDATIONS OF INTERNATIONAL TELEGRAPH AND TELEPHONE CONSULTIVE COMMITTEE WITH RESPECT TO COAXIAL COMMUNICATION CABLES

Moscow ELEKTROSVYAZ' in Russian No 8, Aug 83
(manuscript received 25 Aug 82) pp 57-59

VORONTSOV, A. S. and FROLOV, P. A.

[Abstract] Three recommendations (G.621, 622 and 623) of the International Telegraph and Telephone Consultive Committee, published in the Yellow Book at Geneva in 1981, are pertinent to the characteristics of coaxial pairs of Types 0.7/2.9; 1.2/4.4; and 2.6/9.5 mm. Each of the recommendations contains norms on the structural parameters and electrical characteristics of coaxial pairs. Specifications are furnished on construction lengths and elementary cable units. The principal generalized data with respect to each section are furnished. Tables 9; references 1 (Russian).
[30-6415]

UDC 621.396.69.001.452

OPERATION AND DURATION OF TESTS OF APPARATUS EXPOSED TO INCREASED HUMIDITY

Moscow ELEKTROSVYAZ' in Russian No 8, Aug 83 (manuscript received 12 Oct 82) pp 51-54

KUDASHEV, G. N. and BUROMENSKIY, N. G.

[Abstract] High relative humidity of the air (r = 80 ÷ 100%) is one of the climatic factors which strongly reduce the serviceability of radioelectronic apparatus (REA). Consequently, tests of REA for moisture resistance have a significant value. The conditions of exploitation and the process of testing apparatus exposed to increased humidity are examined. The arrangements for exploitation of surface REA and the mechanism of the effect of moisture on the characteristics of apparatus are shown. Recommendations with respect to test procedures are given. Figures 4; tables 2; references 3 (Russian).
[30-6415]

DISCUSSION OF PROBLEMS OF RADIO INTERFERENCE REDUCTION

Moscow ELEKTROSVYAZ' in Russian No 8, Aug 83 p 25

[Abstract] In May 1983 the Scientific-Technical Council of the USSR Ministry of Communications considered the problem of reducing radio interference induced by powerful radio broadcasting stations in the channels of K-60P systems. The struggle with this interference is complicated by the absence of effective methods for determining its origin. New interference suppression devices, the PPU, were created by the LEIS (Leningrad Electrotechnical Institute of Communications imeni M. A. Bonch-Bruyevich). Tests conducted at LEIS with participation by TTsUMS-3 (expansion unknown) showed that these devices possess adaptiveness, but the stability and effectiveness of suppressing interference, both with respect to carrier frequency (17-21 db) and sideband (5-10 db), are inadequate. Two methods proposed for reducing interference are briefly described. A test lot of PPU-8 interference suppressing devices was developed, including technical documentation concerned with production, assembly and operation on cable main lines. The Scientific-Technical council approve the work performed by LEIS and TTsUMS-3 and made a number of recommendations. [30-6415]

UDC 621.395.664

ESTIMATION OF SIGNAL AND NOISE ENERGY RELATIONS DURING DIGITAL DATA TRANSMISSION

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 26, No 9, 1983 (manuscript received after revision 27 Sep 82) pp 23-29

[Article by Yu. V. Arzumanyan and A. A. Zakharov]

[Text] Algorithms are presented for estimation of the signal/noise ratio by the maximum probability criterion for channels with transmission coefficient constant in the range of estimation and for channels with Rayleigh fading during data transmission by orthogonal signals. Easily realizable estimation algorithms, similar in effectiveness to maximum probability estimates, are considered. The results of statistical modelling of the work of the estimation algorithms are discussed and recommendations are made on practical use of the results.

There is rather frequently a need to estimate signal and noise energy relations during operation of digital message transmission systems. This relation is characterized for channels with fluctuating noise by the ratio of the mean signal energy to the spectral noise density h^2 (signal/noise ratio). The capability of determining the signal/noise ratio permits one to estimate the veracity of the received data, to adapt to a noisy situation in a channel and to monitor the efficiency of the communications system [1-4]. In other words, a knowledge of h^2 is very useful and sometimes also necessary in solution of many digital data transmission problems.

The purpose of this article is to consider the capability of obtaining maximum probability estimates (or estimates close to it) of h^2 during digital message transmission by binary orthogonal signals with equal energy through the linear stochastic channel, to find the statistical characteristics of these estimates and to discuss the results of computer simulation of the derived estimation algorithms.

Let us introduce the following notations: s_1 and s_2 are versions of binary signals, l is the number of signal transmissions in which the value of h^2 is estimated and v_{1i} and v_{2i} $(i=\overline{1,l})$ are the readouts of the signal envelopes at the outputs of filters matched to s_1 and s_2, respectively.

The basis of the suggested approach is an attempt to use as the input statistics $(\lambda_i)_{i=1}^{l}$, where λ_i is the ratio

$$\lambda_i = v_{1i}/v_{2i}. \tag{1}$$

As is easily noted, λ_i is functionally related to the probability ratio (a decision on the transmitted version of the signal can be made upon comparison with the unit threshold with respect to λ_i). Accordingly, there should be a relationship of the parameter of conditional probability density of λ_i with the probability of an error in reception of digital messages. As will be shown below, the advanced hypothesis was constructive and made it possible to find the estimate of the maximum probability of the signal/noise ratio.

Let us first consider the methods of estimation of h^2 for the case of a channel in which the transmission coefficient remains essentially constant in the range of estimation of the signal/noise ratio.

Let the first version of the signal s_1 be transmitted. It is known from [5] that random values v_{1i} and v_{2i} have the following conditional probability densities:

$$W(v_{1i}/s_1) = \frac{v_{1i}}{\sigma^2} I_0\left(\frac{v_{1i}a}{\sigma^2}\right)\exp\left(-\frac{v_{1i}^2+a^2}{2\sigma^2}\right),$$

$$W(v_{2i}/s_1) = (v_{2i}/\sigma^2)\exp(-v_{2i}^2/2\sigma^2),$$

where a and σ^2 are the parameters of distribution laws and $h^2 = a^2/2\sigma^2$ and $I_0(x)$ is a Bessel function of the imaginary independent variable.

Based on known relations, the conditional probability density of λ_i can be represented in the form

$$W(\lambda_i/s_1) = \int_0^\infty \frac{\lambda_i x^3}{\sigma^4} I_0\left(\frac{x\lambda_i a}{\sigma^2}\right)\exp\left(-\frac{x^2\lambda_i^2 + x^2 + a^2}{2\sigma^2}\right)dx. \tag{2}$$

Having performed integration in (2) let us express the conditional probability density in the following manner

$$W(\lambda_i/s_1) = \frac{2\lambda_i}{(1+\lambda_i^2)^2}\left(1 + h^2\frac{\lambda_i^2}{1+\lambda_i^2}\right)\exp\left(-\frac{h^2}{1+\lambda_i^2}\right). \tag{3}$$

The independence of the fluctuating noise in different signal transmissions and expression (3) permit one to write the conditional probability density of the population $(\lambda_1, \ldots, \lambda_l)$ in the form

$$W(\lambda_1, \ldots, \lambda_l/s_1) = \prod_{i=1}^{l} W(\lambda_i/s_1) =$$

$$= 2^l \prod_{i=1}^{l}\left[\frac{\lambda_i}{(1+\lambda_i^2)^2}\left(1 + h^2\frac{\lambda_i^2}{1+\lambda_i^2}\right)\right]\exp\left(-h^2\sum_{i=1}^{l}\frac{1}{1+\lambda_i^2}\right). \tag{4}$$

The maximum probability estimate $\hat{h}^2$ of parameter h^2 according to [6], for example, is the solution of the equation

$$\frac{\partial}{\partial h^2} W(\lambda_1, \ldots, \lambda_I / s_1) = 0. \tag{5}$$

By differentiating (4) with respect to h^2 and by substituting it into (5), we find the following equation

$$\sum_{i=1}^{I} \left[\left(\frac{1+\lambda_i^2}{\lambda_i^2} + h^2 \right)^{-1} - (1+\lambda_i^2)^{-1} \right] = 0, \tag{6}$$

solution of which for $\hat{h}^2$ is the maximum probability estimate.

For example, in the case of estimating the signal/noise ratio in one signal transmission (I = 1), $\hat{h}^2 = (\lambda_1^4 - 1)/\lambda_1^2$ follows from (6).

Unfortunately, at high values of I, the estimation algorithm becomes considerably complicated and is generally not expressed in explicit form at $I > 4$. Although it is rather simple to solve (6) directly by iterative methods of finding the roots with modern computer equipment, it is nevertheless of interest to find the clear estimation algorithm at least for some range of values of h^2. In fact, $\lambda_1^2 >> 1$ with high probability at $h^2 >> 1$. Then, disregarding the units in the expressions under the summation sign in (6), we find

$$\hat{h}_1^2 = \left(\frac{1}{I} \sum_{i=1}^{I} \frac{1}{\lambda_i^2} \right)^{-1}. \tag{7}$$

As indicated by statistical modelling results, the estimation algorithm for h^2 is sufficiently accurate for a wide range of values of signal/noise ratio as a mean harmonic value of the squares of statistics $\lambda_1 \ldots \lambda_I$ of (7). Thus, the shift of estimate h_1^2 does not exceed 20 percent at $I \geq 10$ and $h^2 \geq 4$.

Let us now turn to consideration of the communications channel, the transmission coefficient of which is a random value distributed by Rayleigh law (a communications channel with Rayleigh fading).

The conditional probability densities of v_{1i} and v_{2i} have the following form in this case [5]:

$$W(v_{1i}/s_1) = (v_{1i}/\sigma_1^2) \exp(-v_{1i}^2/2\sigma_1^2), \quad W(v_{2i}/s_1) = (v_{2i}^2/\sigma_2^2) \exp(-v_{2i}^2/2\sigma_2^2), \tag{8}$$

where σ_1^2 and σ_2^2 are the parameters of the distribution laws. Moreover, the mean value of the signal/noise ratio h^2 is determined as $\tilde{h}^2 = (\sigma_1^2/\sigma_2^2) - 1$.

As in the previous case, let us form ratio (1) on each signal transmission. Using (8), it is easy to determine the conditional probability density of the value

$$W(\lambda_i/s_1) = 2\lambda_i(1+\tilde{h}^2)/(1+\tilde{h}^2+\lambda_i^2)^2. \tag{9}$$

Assuming that the fluctuating noise and values of the transmission coefficient of the communications channel in different signal transmissions are independent, the joint conditional probability density of the population $(\lambda_1, \ldots, \lambda_I)$ can be written by using (9):

$$W(\lambda_1, \ldots, \lambda_I/s_1) = \prod_{i=1}^{I} W(\lambda_i/s_1) = 2^I(1+\tilde{h}^2)^I \prod_{i=1}^{I} [\lambda_i/(1+\tilde{h}^2+\lambda_i^2)^2]. \tag{10}$$

To find the maximum probability estimate, let us substitute (10) into (5), as a result of which we find the equation

$$\sum_{i=1}^{I} [(1+\tilde{h}^2-\lambda_i^2)/(1+\tilde{h}^2+\lambda_i^2)] = 0, \tag{11}$$

solution of which of $\tilde{h}^2$ will also be the desired estimate.

For example, in the case of estimation of $\tilde{h}^2$ on a single signal transmission ($I = 1$), $\hat{h}^2 = \lambda_1^2 - 1$ follows from (11).

One can show by the mathematical induction method that solution of equation (11) is equivalent to finding the positive root of the polynomial

$$\begin{aligned} P_I(\tilde{h}^2+1) = I\left\{\left[(\tilde{h}^2+1)^I \Big/ \prod_{i=1}^{I}\lambda_i^2 - 1\right]\right\} + \sum_{i=1}^{I/2}(I-2i) \Big/ \prod_{i=1}^{I}\lambda_i^2 \times \\ \times \left[(\tilde{h}^2+1)^{I-i} \sum_{j_1<\ldots<j_i} \lambda_{j_1}^2 \ldots \lambda_{j_i}^2 - (\tilde{h}^2+1)^i \sum_{j_1<\ldots<j_{I-i}} \lambda_{j_1}^2 \ldots \lambda_{j_{I-i}}^2\right], \end{aligned} \tag{12}$$

where [x] is the whole part of x.

According to the Descartes rule [7], the polynomial $P_I(\tilde{h}^2+1)$ has a single positive root. Finding this root by iterative methods presents no special difficulty, but it is still desirable to have an explicit expression to design measuring devices. As indicated by statistical modelling, the explicit estimation algorithms found from (12) with low order of approximations, have impermissibly large dispersion and bias and cannot be recommended for practical use. An increase of the order of approximation leads to sharp complication of the algorithm.

Let us make use of the following procedure to find a simple and sufficiently accurate method of estimation. Let us conditionally divide the polynomial $P_I(\tilde{h}^2+1)$ into two terms $g_1(\tilde{h}^2+1)$ and $g_2(\tilde{h}^2+1)$ and let us find the root $\tilde{h}_2^2$ of the term $g_1(\tilde{h}^2+1)$. If it turns out in this case that the mean value of $g_2(\tilde{h}_2^2+1)$ is equal to zero, as follows from the properties of convergence by probability [8], the value of $\tilde{h}_2^2$ converges by probability to estimate $\tilde{h}^2$, found with accurate solution of (11).

It can be proved as a result of rather cumbersome calculations that at

$$g_1(\tilde{h}^2+1)=I\left\{\left[(\tilde{h}^2+1)^I\Big/\prod_{i=1}^{I}\lambda_i^2\right]-1\right\} \tag{13}$$

all the above enumerated requirements are fulfilled.

Thus, the root of polynomial (13)

$$\hat{h}_2^2=\sqrt[I]{\lambda_1^2\lambda_2^2\ldots\lambda_I^2}-1 \tag{14}$$

converges by probability to precise solution of equation (11) at any value of I.

The simplicity of estimate $\hat{h}_2^2$ as the mean geometric value without unity from the squares of statistic $\{\lambda_i\}_{i=1}^{I}$ permits one to calculate the bias and dispersion of the estimate by the following formulas:

$$M(\hat{h}_2^2)-\tilde{h}^2=(\tilde{h}^2+1)\left[\left(\frac{\pi/I}{\sin\pi/I}\right)^I-1\right], \tag{15}$$

$$D(\hat{h}_2^2)=(\tilde{h}^2+1)^2\left[\left(\frac{2\pi/I}{\sin 2\pi/I}\right)^I-\left(\frac{\pi/I}{\sin\pi/I}\right)^{2I}\right]. \tag{16}$$

All the foregoing was made with respect to the estimation algorithms on the assumption of transmission of signal s_1. As is easily noted, upon transmission of s_2, shaping of λ_i in the form of $\lambda_i=v_{2i}/v_{1i}$ provides invariance of the algorithms and the statistical characteristics of the estimates.

In the case of the absence of a priori information about the version of the signal to be transmitted, the manipulation must be removed for use of the derived results, for example, by formation of each statistic of λ_i as a ratio greater than the value of the readout of the envelope among v_{1i} and v_{2i} at the output of the matched filter to the lesser value. All the algorithms presented above remain effective in this case.

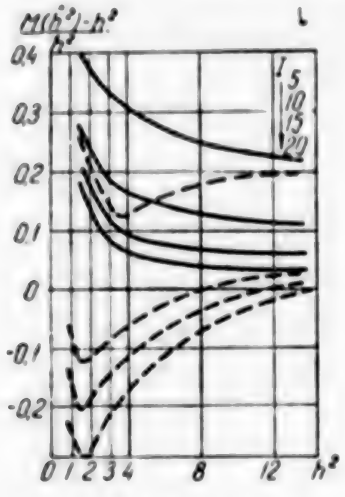

Figure 1

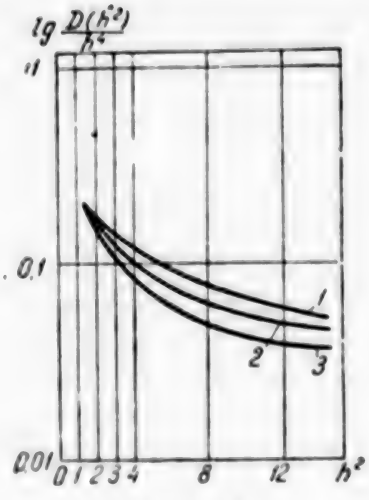

Figure 2

Thus, the derived algorithms permit one to find the estimate of the maximum probability of the signal/noise ratio precisely ((6) or (11)) or approximately ((7) or (14)). To do this, it is sufficient to have available the values of the readouts of the signal envelopes at the outputs of the matched filters.

Statistical modelling on the YeS-1022 computer was carried out to check the effectiveness of the proposed algorithms. The bias and dispersion of estimates $\hat{h}_1^2$ and $\hat{h}_2^2$ and precise solutions of the probability equations (6) and (11) were determined as a result of modelling. A precise solution of the probability equations was obtained by the "golden section" method with guarantee of not more than a 2 percent error in finding the root. The volume of the samples in determination of the biases and dispersions was selected from the condition of guaranteeing a 5 percent confidence interval with probability of 0.995. The calculation was made both with known and unknown versions of the signal to be transmitted. The signal/noise ratio was estimated on 5, 10, 15 and 20 signal transmissions. The estimation in the communications channel with constant transmission coefficient was made for signal/noise ratios of 1, 2, 3, 4, 8, 12 and 16. The value of $\tilde{h}^2$ was equal to 1, 6, 11, 16, 21 and 26 in the channel with Rayleigh fading. The results of statistical modelling permit one to make the following conclusions:

1. In the case of estimation of the signal/noise ratio in a channel with constant transmission coefficient:

a) the maximum probability estimate (solution of equation (6)) of h^2 has a bias distinct from zero and the dependence of the bias related to the true value of the signal/noise ratio on h^2 at different value of I is noted by the solid curves in Figure 1; as follows from the graphs, the bias of the maximum probability estimate does not exceed 10-15 percent of h^2 at $h^2 \geq 3$ and $I \geq 10$ and similar function for estimate $\hat{h}_1^2$, found by algorithm (7), are drawn by the dashed curves;

b) the dispersion of estimate $\hat{h}_1^2$ is close to that of the maximum probability estimate and differs from it by no more than 5-10 percent, for example, curve 1 in Figure 2 indicates the dependence of the logarithm of the dispersion ratio to the square of h^2 for the maximum probability estimate at I equal to 15, curve 2 shows a similar dependence for estimate $\hat{h}_1^2$ found by algorithm (7) and curve 3 shows the lower bound found by using the Rao-Kramer inequality; the nature of the considered functions are completely preserved for other values of I;

c) removal of the manipulation is reflected approximately identically both in precise solution of the probability equation (7) and in approximate algorithm (7) and an increase of the bias ΔM can be estimated by empirical formulas $\Delta M(\hat{h}^2) \approx 1.63 \sqrt{I h^2}$ and $\Delta M(\hat{h}_1^2) \approx 0.89 \sqrt{I h^2}$, respectively; the dispersions of the estimates increase by approximately 10-15 percent at $h^2 \geq 2$ and $I \geq 10$.

2. In the case of estimation of the mean value of the signal/noise ratio in a channel with Rayleigh fading:

a) the maximum probability estimate is characterized by bias and dispersion that are practically coincident with the corresponding characteristics of estimate $\hat{h}_2^2$ of (14) and their values can be calculated by formulas (15) and (16). Thus, for example, the bias of the estimate does not exceed 10-15 percent of $\bar{h}^2$ at $\bar{h}^2 \geqslant 6$ and $I \geqslant 10$;

b) the unbiased estimation algorithm can be found from (14) and (15) in the form $\hat{h}_3^2 = \{|\sin(\pi/I)|/(\pi/I)\}^I \cdot \overline{\lambda_1^2 \ldots \lambda_I^2} - 1$ with dispersion of the estimate $D(\hat{h}_3^2) = (\bar{h}^2 + 1)^2 \{|(\mathrm{tg}(\pi/I))/(\pi/I)|^I - 1\}$;

c) removal of the manipulation leads to an increase of the dispersions of the estimates by approximately 15-20 percent and to an increase of the biases and the increase of the bias can be determined as $\Delta M(\hat{h}^2) = 2/(1{,}7\bar{h}^2 - 0{,}7)$, $\Delta M(\hat{h}_2^2) = 2{,}5/(1{,}3\bar{h}^2 - 0{,}3)$ and $\Delta M(\hat{h}_3^2) = 2{,}1/(1{,}4\bar{h}^2 - 0{,}4)$, respectively, for precise approximate and unbiased estimation algorithms.

The results of analysis of the effectiveness of the proposed estimation algorithms for the signal/noise ratio and statistical modelling data permit one to recommend approximate algorithm (7) for channels with constant transmission coefficient as one that provides a bias and dispersion hardly differing from the corresponding characteristics of the maximum probability estimate and one having comparatively simple realization. The unbiased estimation algorithm can be recommended for channels with Rayleigh fading as the simplest and one having the least dispersion compared to the maximum probability estimate.

One can limit oneself to the statistics found in 10-15 signal transmissions for both types of communications channel, since an increase of the complexity of realization with an increase of the volume of the statistics cannot be justified in most cases by some increase of the effectiveness of the estimates.

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CSO: 8144/0311A

UDC 621.395.5:621.372.544

OPTIMUM AND QUASI-OPTIMUM DIGITAL FILTERS FOR ANALOG-TO-DIGITAL CONVERTERS

Moscow ELEKTROSVYAZ' in Russian No 8, Aug 83 (manuscript received 12 May 82) pp 19-2?

GOL'DENBERG, L. M., MATYUSHKIN, B. D., and POLYAK, M. N.

[Abstract] The paper is concerned with an improvement of the optimality criterion of digital filters (DF) for a variation of analog-to-digital converters, and consideration of the circuits of some optimum and quasi-optimum filters. The following items are discussed:

1) First optimality criterion of DF. A class of nonrecursive DF (NDF) of order N with transfer functions is described.
2) Frequency characteristics of NDF1.
3) Feasibility of NDF1.
4) Quasi-optimum NDF; and
5) Second optimality criterion of DF.

The methodology considered makes it possible to solve the problem of type selection and to estimate the characteristics of optimum NDF intended for use in analog-to-digital converters. Figures 3; tables 2; references 8: 4 Russian, 4 Western.
[30-6415]

UDC 621.382

OUTLOOK FOR USE OF ELECTRICAL MODELS OF SMALL ELEMENTS IN CIRCUIT DESIGN FOR LARGE-SCALE INTEGRATION WITH BIPOLAR STRUCTURES

Moscow MIKROELEKTRONIKA in Russian Vol 12, No 5, Sep-Oct 83
(manuscript received 22 Jul 82) pp 440-451

PETROSYANTS, K. O., Moscow Institute of Electronic Machine Building

[Abstract] The use of electrical models in circuit design for large-scale-integration is reviewed and modifications of existing models are proposed which will take into account the microminiature size of bipolar silicon structures. The principal problematic consequences of small size are high resistances and pronounced two-dimensionality effects. Consequently, in modeling ECL and I^2L elements of submicron sizes it is very important to represent correctly the resistances of 3-dimensional regions, including those of metallized contacts, as well as their effect on static and dynamic characteristics of LSI circuits. The existing models IBIS-BIRD, Ebers-Moll (EM-3) and Gummel-Puhn (GP) are considered as references. A variant is shown of new models which combine electrical and physico-topological parameters, suitable for design of picosecond and nanosecond LSI devices on the principles of functional integration. It is based on second-order differential equations for six currents flowing in a bipolar transistor: volume-recombination current in neutral base; volume-recombination current in depletion layer of p-n junction; hole currents injected from base into emitter and into collector, respectively; current of surface recombination at boundary between SiO_2 layer and space-charge region; current of recombination at Si-SiO_2 interface. This model is demonstrated on an injection-type RS trigger. Existing computer programs can be easily modified for implementation of the algorithms in accordance with such a model.
Figures 8; tables 1; references 33: 20 Russian, 13 Western.
[18-2415]

UDC 681.32.001.2

ESTIMATING DYNAMIC ERROR OF ASTATIC FILTERS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE
in Russian Vol 26, No 6, Jun 83 (manuscript received 5 Oct 82) pp 38-41

KORSHUNOV, Yu. M., SIMKIN, A. V. and KORSHUNOV, M. Yu., Ryazan Institute of Radio Engineering

[Abstract] The dynamic error of astatic filters can be estimated directly as a function of the signal, namely as the difference between the signal and its estimate. This method is applicable not only to analog filters but also to digital ones, provided the quantization frequency is higher than

double the cutoff frequency of the equivalent continuous part of the filter. The signal is expanded into a Taylor series while, in the case of a filter with finite memory, estimates of the signal and its derivatives are obtained by the method of least squares to form a corresponding polynomial. Solution of the system of equations resulting from the minimization criterion yields simple estimates of the signal and its derivatives by polynomials of one order lower than the order of filter astatism. These estimates can be extended to filters with expanding memory. The procedure is demonstrated on smoothing a sinusoidal signal with interference, and the dynamic error is estimated in this case as a function of the readout interval $\alpha=\omega\lambda$ (ω- frequency of signal, λ- length of filter memory). The paper was recommended by the Kafedra (Department) of Automatics and Telemechanics. Figures 1; tables 1; references 4 (Russian).
[19-2415]

UDC 62-50

OPTIMAL PARAMETRIC SYNTHESIS OF ELECTRIC FILTERS WITH MAXIMUM BANDWIDTH

Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian No 3, May-Jun 83 (manuscript received 6 Feb 81, after completion 7 Jan 82) pp 198-200

GERASIN, M. L., Syktyvkar

[Abstract] The problem of synthesizing an electric filter for maximum frequency, phase, or time range under certain constraints on performance can be either treated as an extremization problem with coupled constraints or solved by numerical means. A variant of the numerical method is demonstrated on the problem $T\to\max$, $E(T):=\min\limits_{a\in R^n}\max\limits_{t\in[t_1,T]}\{f(a,t)\leq b\}$ with t_1 fixed and the function $f(\overset{a}{\alpha},t)$ assumed to be continuous non-negative. Considering that $E(T)$ is necessarily a continuous nondecreasing function, the existence and form of $E'(t)$ are established. An exact evaluation of $E'(T)$ requires only an exact solution of the minimax equation $E(T)=b$, which can be done by the Newton method. This procedure is particularly applicable to ladder filters with t denoting the frequency and $f(\alpha,t)$ denoting the modulus of the reflection coefficient squared. Figures 1; references 8 (Russian).
[20-2415]

UDC 621.396.62

OPTIMIZATION OF HF CHANNEL OF DIGITAL SIGNAL RECEIVERS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian
Vol 29, No 9, 1983 (manuscript received after revision 20 Jul 82) pp 71-72

[Article by V. V. Palshkov]

[Text] The noise stability of reception [1, 2] in a real electromagnetic situation is determined not only by the signal and noise characteristics, but also to a significant degree by the non-linear interaction of oscillations in the HF channel of the receiver up to the main selectivity filter. The non-linearity of the HF channel is characterized by indices of effective selectivity of the receiver [3], which determine the veracity of message reproduction. These indices include non-linearity of the amplitude characteristic of the channel, cross- and intermodulation and the intensity of spurious receiving channels.

We call the receiver in which there is no internal noise and no non-linear interaction of signal and noise the optimum receiver. The useful signal and external noise, located in the bandpass of the main selectivity filter, are fed to the resolving unit in this receiver. The presence of this noise determines the error probability B_n of receiving the signal elements by the optimum receiver.

In a real receiver, the error probability B_r exceeds B_n due to deterioration of the signal/noise ratio. This receiver is characterized by the coefficient of increasing the error probability or rather by the error coefficient

$$k_{ош} = B_p/B_n. \quad (1)$$

The error probability of a real receiver is a complex function of the mode of its components and structure

$$B_p = \Phi_p(\alpha_p, \beta_p, \gamma_p, \ldots, q_p), \quad (2)$$

where α_r, β_r, γ_r, ... are the characteristics of the receiver that determine the noise stability such as the shape of the amplitude-frequency and phase-frequency characteristics, the threshold level of the resolving device and so on, $q = (U_{pr}/U_{sr})^2$ is the square of the ratio of effective values of noise U_{pr} to signal U_{sr} voltage at the output of the HF channel of a real receiver.

The error probability of the optimum receiver, similar to relation (2), will be:

$$B_н = \Phi_н(\alpha_н, \beta_н, \gamma_н, ..., q_н), \tag{3}$$

where α_n, β_n, γ_n, ... are the characteristics of the optimum receiver and $q_n = (U_{pn}/U_{sn})^2$ is the square of the ratio of effective values of noise U_{pn} to signal U_{sn} voltages at the output of the HF channel of the optimum receiver.

Let us represent (2) and (3) in the form of Taylor series, where we use q_r and q_n as independent variables, and accordingly we find:

$$B_р = \Phi_р(\alpha_р, ..., 0) + \Phi'_р(\alpha_р, ..., 0)\, q_р + ..., \tag{4}$$

$$B_н = \Phi_н(\alpha_н, ..., 0) + \Phi'_н(\alpha_н, ..., 0)\, q_н + ... \tag{5}$$

Let us take into account that $q_n = 0$, $q_r = 0$, $B_n = 0$ and $\Phi_n(\alpha_n, ..., 0) = 0$ in the absence of noise and moreover, let us assume that the structure of modern signal processing devices permits one to realize $B_r = 0$ at $q_r = 0$. Therefore, $\Phi_r(\alpha_r, ..., 0) = 0$.

Low error probabilities, realized according to (4) and (5) at small values of q, are of significant interest to practice. This permits one to limit oneself only to the second terms in expressions (4) and (5). According to (1) and also according to (4) and (5) at small values of q, we find

$$k_{ош} \approx [\Phi'_р(\alpha_р, ..., 0)/\Phi'_н(\alpha_н, ..., 0)]\,(q_р/q_н). \tag{6}$$

One can achieve signal processing close to ideal in modern receivers; therefore, $\Phi'_р(\alpha_р, ..., 0) = \Phi'_н(\alpha_н, ..., 0)$. With these assumptions, relation (6) determines the error coefficient in the form

$$k_{ош} \approx q_р/q_н = [(U_{пр}/U_{ср})/U_{пн}/(U_{сн})]^2. \tag{7}$$

Relation (7) coincides to formula (7), derived in [4], and can be expressed by the effective selectivity characteristics.

The signal voltage at the output of the optimum channel is $U_{sn} = K_0 E_A$.

The signal voltage at the output of the real channel is $U_{ср} = K_0 E_A (1 + k_Б - k_н)$, where K_0 is the amplification factor of the channel, k_n is the coefficient of nonlinearity of the amplitude characteristic, k_B is the interlocking coefficient (usually $k_n < 0$ and $k_B < 0$) and E_A is the signal EMF in the antenna. The noise voltage at the output of a real channel is determined by the equivalent noise voltage in the required signal band, coinciding with the equivalent noise voltage at the output of the optimum channel, which can be written in the form of Nyquist formula $U^2_{пш} = 4k\alpha T_0 R_A \Delta f\, K_0^2$, where α is the relative noise temperature of the antenna, determined by the noise level at the reception point, by the noise voltage of the receiver $U^2_{шп} = 4kT_0 R_A (K_ш - 1)\,\Delta f\, K_0^2$, where T_0 is normal temperature and K_{sh} is the noise coefficient of the receiver, by the noise

voltage determined by cross-modulation $U^2_{pp} = k^2_p U^2_{sn} K^2_0$, where $k_п = U_{пп}/K_0 U_{сн} = U_{пп}/U_{сн\ вых}$ is the cross-modulation coefficient, by the noise voltage due to intermodulation $U^2_{п\ вз} = k^2_{вз} U^2_{сн} K^2_0$, where $k_{vz} = U_{п\ вз}/U_{сн\ вых}$ is the coefficient of intermodulation distortions, and by the noise voltage of spurious receiving channels $U^2_{поб} = k^2_{поб} U^2_{сн} K^2_0$, where $k_{поб} = U_{поб}/U_{сн\ вых}$ is the noise coefficient determined by spurious receiving channels. The total noise voltage at the output of a real channel is $U^2_{пр} = U^2_{пн} + U^2_{шп} + U^2_{пп} + U^2_{п\ вз} + U^2_{поб}$.

Thus, $k_{ош} = \{[(K_ш - 1)/\alpha] + 1 + \gamma_1^2 (k^2_п + k^2_{вз} + k^2_{поб})\}/(1 + k_н + k_Б)^2$, where $\gamma_1 = U_{сн}/U_{пн}$ is the signal/noise ratio at the output of the HF channel of an optimum receiver. It is obvious that bringing the results of reception closer to the optimum is realized with minimum error coefficient.

If the structure and component base of the channel and the electromagnetic situation are given, one can find the optimum mode of the channel components, realization of which permits one to achieve minimum error probability of message reproduction. The search for the optimum solution reduces to recording k_{osh} in the function of the parameters of the component base with regard to data of the electromagnetic situation and to determination of the conditions for achieving the minimum value of this function. The indicated procedure permits one to find the optimum values of the mode of the HF channel.

The noise stability of a receiver constructed on a real component base is determined by its non-linearity characteristics: interlocking, intermodulation, cross-modulation, level of spurious receiving channels, non-linearity of the amplitude characteristic and also by the natural noise level. The error coefficient, equal to the ratio of the error probabilities of real and optimum receivers, is a function of the characteristics of the component base and can be minimized by selection of the optimum transmission coefficients of the structural components of the channel.

The results of optimization are presented in [4] with respect to the structure of a superheterodyne receiver under special conditions.

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CSO: 8144/0311B

UDC 621.395.37:654.15

TEST OF USE OF ATMYe TYPE OF AUTOMATIC MONITORING AND TESTING APPARATUS AT KIEV LONG-DISTANCE TELEPHONE EXCHANGE

Moscow ELEKTROSVYAZ' in Russian No 8, Aug 83
(manuscript received 22 Sep 81) pp 37-39

GORBUNOV, S. M.

[Abstract] Problems of its use and the distinctive features of the ATMYe type automatic monitoring and testing apparatus are considered, and the organization of its work is described. In the course of 24 hours the ATMYe apparatus operates continuously for 11-13 hours, which assures fulfilment of three basic forms of work: night and day inspection of channels, as well as the measurement of the losses of telephone communications at reference directions by the monitoring trunks method. The 10-year exploitation of the ATMYe apparatus at the Kiev long-distance telephone exchange demonstrated its high efficiency, reliability and stability in operation. Specific examples of gains from its use are given.
[30-6415]

UDC 621.395.4

NOISE IMMUNITY SYSTEM FOR CYCLIC SYNCHRONIZATION OF DIGITAL TRANSMISSION SYSTEM WITH EXTRACTION OF CHANNELS

Moscow ELEKTROSVYAZ' in Russian No 8, Aug 83 (manuscript received 5 Oct 82)
pp 15-18

VORONTSOV, I. I.

[Abstract] The paper describes a noise immunity system for cyclic synchronization (SCS) which makes it possible to obtain an accuracy of transmission not found in existing digital transmission systems (DTS) without extraction of channels. This system is put into practice in the IKM-30S, the primary DTS for rural telephone networks. An analysis is made

of random models of an ordinary and an optimized SCS. Because of the gain obtained by the use of an optimum receiving device for cyclic synchronization it is possible to evaluate the certainty of digital information transmission, which is increased as the result of a decrease of the probability of nonsynchronous operation of the SCS. During this the time of nonsynchronized operation in comparison with ordinary SCS is decreased by 2-3 orders. Figures 5; tables 1; references 8: 6 Russian, 2 Western (1 in Russian translation).
[30-6415]

UDC 519.2

METHOD OF ALLOCATING BUFFER MEMORY IN SWITCHING CENTER TO CHANNELS

Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA
in Russian No 3, May-Jun 83 (manuscript received 26 Jan 82) pp 192-195

BORODINA, Ye. S., Moscow

[Abstract] In order to allocate correctly the buffer memory in a switching center to the message transmitting channels, it is necessary to estimate the throughput and the probability of message loss characterizing the center as well as the maxima and minima of queues at the channels which will optimize those two performance parameters. Solution of this problem of optimal dynamic allocation is very difficult and, therefore, a simplification is proposed. As the mathematical model, a set is selected of L single-channel $M|M|1|n$ queuing arrays with at least $\underline{x}_i$ buffer sites permanently fixed behind each and a Poisson message flux (intensity λ_i) is assumed to enter each channel with exponential distribution of queuing time (mean queuing time $1/\mu_i$). Both the lower bound $\underline{x}_i$ and the upper bound $\bar{x}_i$ of the number of buffers are determined approximately, both according to the principle of equalizing the losses in all directions. Each queuing array is described by a multidimensional Markov "annihilation and multiplication" process and a corresponding graph of transitions. The exact system of equations for the two-dimensional case (L=2) is formulated accordingly and solved, whereupon the probabilities of message loss are estimated approximately for a constant message flux. The problem becomes more complicated in the case of channels with different priorities or different limits on permissible message loss, but the method of solution remains the same with only a larger amount of computations. Figures 2; references 2 (Western).
[20-2415]

UDC 669.14.018.5

MODERN ELECTRICAL-GRADE STEELS

Moscow ELEKTROTEKHNIKA in Russian No 6, Jun 83
(manuscript received 31 Jan 83) pp 33-36

MOLOTILOV, B. V., doctor of technical sciences, professor, and
MIRONOV, L. V., candidate of technical sciences, Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] Electrical-grade steels have been produced in the Soviet Union since 1928, particularly rapid progress having been made since 1941. There are basically three generations of steels now used by the electrical machine industry: 1) hot rolled strip steel (GOSTs 802-41 and 802-58); 2) cold-rolled oriented and nonoriented strip steel (GOST 802-58); 3) cold-rolled oriented and nonoriented sheet steel (GOST 21427-75). Electrical grades include carbon steels as well as alloy steels. While production of hot-rolled steels is to be discontinued within the next few years, the goals for the fourth generation of electrica-grade steels are to reduce the core loss $P_{1.7T/50Hz}$ in 0.3-0.35 mm gage steels to 1.00-1.05 W/kg, to increase the plasticity of metal and core plating, to develop heat-resistant magnetic core plating for 900-950°C in air or inert gas, to produce low-noise transformer steel with low magnetostriction, to produce 0.5 mm gage transformer steel for large electric machines operating at 800°C, to improve the overall quality of nonoriented steels, and to develop a high-frequency cold-rolled steel. These goals ought to be achieved by minimizing the impurity content in the metal, optimizing the grain characteristics, fully utilizing the properties of the metal, and optimizing the semifinished product. Attention must also be paid to the core plating. Two new trends will greatly influence not only the quality of the steel product but also the performance of the electric machines, namely the use of new amorphous materials and the construction of wound rather than stacked stator cores. Fourth-generation nonoriented steel is expected to dominate the field during the coming 10-15 years, unless breakthrough discoveries pertaining to metallophysical properties or radical inventions pertaining to technology of machine construction are made. Perfect nonoriented steel on the basis of a cubic texture may become economically feasible in the fifth generation. Tables 2.
[17-2415]

UDC 621.395.65:621.318.5

SWITCHING MATRIX ON BASE OF HYBRID-INTEGRATED CIRCUIT

Moscow ELEKTROSVYAZ' in Russian No 8, Aug 83
(manuscript received 23 Jul 82) pp 43-44

GRITCHENKO, V. N., IBAYEV, Yu. K., KUSHNER, V. G., SOSNOVIKOV, V. V. SOKOLOV, V. N. and FILIPENKOV, V. V.

[Abstract] Microelectronics-type miniaturization was used during creation of an apparatus to be used for automated switching of network routes. The Central Design Office (TsKB) of the USSR Ministry of Communications, together with the Central Scientific-Research Institute of Communications (TsNIIS) developed for this apparatus a switching element based on hybrid-integrated circuits, and a switching matrix type on their base. These units are described and a circuit diagram is presented. Figures 2; tables 1; references 2 (Russian).
[30-6415]

UDC 621.357.7

NICKEL-BASED COATING ON LOW-CURRENT CONTACTORS

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 8, Aug 83
(manuscript received 21 Jun 82, after completion 24 Nov 82) pp 49-52

LEUSOVA, ALEKSANDRA IVANOVNA, candidate of physico-mathematical sciences, docent, MOROZOVA, MAYYA EFIMOVNA, candidate of technical sciences, senior scientific associate, and BUBLIKOV, YEVGENIY ILIODOROVICH, graduate student, Novocherkassk Polytechnic Institute

[Abstract] In a search for coatings of nonprecious metals on low-current contactors, a coating material was produced electrolytically at 70-80°C from the 20 g/l $NiSO_4 \cdot 7H_2O$+50 g/l $Na_2WO_4 \cdot 2H_2O$+66 g/l $C_3H_4(OH)(COOH)_3$ electrolyte. The coating has a high resistance to etchants such as $FeCl_3$ and $CuCl_2$ solutions and a surface luster or semiluster, a microhardness of 180 kgf/mm^2 and a strong bond to the substrate metal. The contact resistance, depending on the cathode current density, is 20 mohm at 50 mA/cm^2 and 18 mohm at 120 mA/cm^2 or somewhat higher when the coating is produced at higher temperature. This low contact resistance has been attained by minimizing the initial tungsten content in the alloy, it can be further decreased to 8 mohm at 150 A/cm^2 by lowering the tungsten content further with the addition of 0.2-2 g/l thiourea to the electrolyte. A metallographic analysis with a DRON-1.5 x-ray diffractometer of α-Fe lines has revealed high radiation intensity at low scattering angles and an NiOH-depletion layer at the cathode surface favorable to formation of a homogeneous fine-grain deposit throughout the entire coating thickness. Figures 4; references 4 (Russian).
[21-2415]

UDC 539.2

CLEANING SILICON OF IMPURITIES BY MEANS OF INTERNAL GETTER

Moscow MIKROELEKTRONIKA in Russian Vol 12, No 5, Sep-Oct 83
(manuscript received 31 Jan 83) pp 432-439

NEMTSEV, G. Z., PEKAREV, A. I.,and CHISTYAKOV, Yu. D.

[Abstract] The defectiveness of active silicon surfaces in integrated-circuit chips can be effectively decreased by internal gettering at the drains. This process remains efficient over long periods of heat treatment, but its successful application is predicated on the solution of several fundamental problems. The two main problems are reed-like nonuniform distribution of precipitation-dislocation complexes and poor reproducibility of longitudinal and radial oxygen concentration profiles. The results of theoretical and experimental studies not only reveal how the properties of the substrate material in the surface layer and the performance characteristics of silicon devices, with MOS or bipolar structure, are affected by such defects as packing flaws, dislocation, oxygen impurity, carbon impurity, or metal impurity, but also indicate the sources of these defects produced during the various stages of fabrication and integration, especially during heat treatment. On the basis of these data guidelines are established for producing an efficient internal getter with oxygen precipitate, the principal factor being the correct nucleation rate $J=n^*Z\omega^*$ (n^*- equilibrium concentration of critical nucleation centers, ω^*- frequency of oxygen jump-overs into critical nucleation center, Z- Zel'dovich constant). Explication of these three parameters reveals that the nucleation rate depends on the enthalpy of oxygen dissolution in silicon ($6.67 \cdot 10^{10}$ erg/cm^3), the oxygen-saturation temperature for silicon (T_E = 1573 K when $N_{O_2} = 11 \cdot 10^{12}$ cm^{-3}), and the subcooling factor $(T_E - T)/T_E$. Internal gettering should both improve and stabilize the structural and electrophysical characteristics of silicon wafers, thus also making larger chips and higher degrees of integration feasible. Figures 8; tables 2; references 22: 2 Russian, 20 nonRussian. [18-2415]

BASIC TECHNOLOGY OF MICROPROCESSORS

Moscow AVTOMATIKA, TELEMEKHANIKA I SVYAZ' in Russian No 9, Sep 83 pp 34-36

BORISENKO, L. I., candidate of technical sciences

[Abstract] This item is a continuation of an article in ATIS, No 8, 1983. An elementary explanation is presented of the technology involved in present-day production of various types of microprocessors. It is noted that a little more than 10 years ago creation of complicated electron devices similar to microprocessors was a problem for specialists working in the field of microelectronics. Now, however, such elements exist, series manufactured, and available to development engineers. Series-produced microprocessors cost about 20 rubles, i.e., in practice it is possible for one kopeck to "weigh out" several tens of the transistors in its structure. Figures 5; references 4: 3 Russian, 1 Hungarian (in Russian translation).
[28-6415]

UDC 681.142

DESIGN OF MAGNETIC FIELD FOR PERCUSSION HAMMER ARRAY IN ALPHANUMERIC PRINTER FOR COMPUTER

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 8, Aug 83 (manuscript received 19 Nov 82) pp 10-12

YERSHOV, YURIY KONSTANTINOVICH, senior instructor,
KIRSANOV, ALEKSANDR GEORGIYEVICH, assistant, NIKITENKO, ALEKSANDR GRIGOR'YEVICH, candidate of technical sciences, docent, PEKKER, IOEL' IOSIFOVICH, candidate of technical sciences, docent, and TKACHENKO, GENNADIY IVANOVICH, candidate of technical sciences, docent, Novocherkassk Polytechnic Institute

[Abstract] Magnetic field calculations are shown which pertain to an array of percussion hammers in the alphanumeric printer for a computer. Such an array consists of two parallel rows of oppositely magnetized permanent magnets, each magnet 4 mm long with a 26.5x8 mm^2 cross section, the air gap between the two rows being 4 mm wide and the air gap between each two

adjacent magnets in a row being 1.08 mm wide for a coil of that height. The two rows are connected magnetically in series into a loop by two lateral jumpers, one at each end, made of magnetically soft material. The calculations are based on the field equation for the magnetization vector div $\bar{M} = 0$ and the known $B = f(H)$ demagnetization curve for the magnet material, with edge effects and variance between magnets in terms of their magnetic properties disregarded. The integrals in the infinite series for α_j in

$$\alpha = \sum_{j=1}^{\infty}, \quad \langle H_x \rangle = \alpha M_x + \langle H_x^{\delta} \rangle \text{ and } \langle B_x \rangle = \mu_0(1 + \alpha)M_x + \mu_0 \langle H_x^{\delta} \rangle$$

(<> - mean over cross section, H_1^{δ} - magnetic field intensity produced a point N in i-th magnet by 1-th coil), are evaluated analytically. The coefficient α is then calculated numerically, accuracy of orders 0.001 and 0.0001 yielding practically the same result. A comparison with experimental data reveals that assuming $\langle B_x^{\delta} \rangle = 0.39$ T in the calculations results in an error not larger than 5%. Figures 2; references 2 (Russian).
[21-2415]

UDC 621.382

EVALUATION OF MEAN LENGTH AND ROUTING CAPACITY OF INTERCONNECTIONS IN LARGE-SCALE-INTEGRATION ARRAYS FOR COMPUTERS

Moscow MIKROELEKTRONIKA in Russian Vol 12, No 5, Sep-Oct 83
(manuscript received 20 Jan 83) pp 457-463

FAYZULAYEV, B. N.

[Abstract] Interconnections in LSI and VLSI arrays for computers are analyzed from the standpoint of layout optimization. Their mean length and routing capacity (total number of routes) are calculated for an arbitrary random spacing of circuit elements and an orthogonal routing scheme, on the basis of the Donath hierarchical model describing a rectangular LSI array chip and the Rente equation relating the average number n of external connections for a logic module to the degree of integration N (number of logic elements on a chip): $n = \alpha N^p$ (α- design factor, p- Rente exponent). Analysis and calculations reveal that with $p = 1/2$, typically, the mean length of interconnections in the optimum layout is proportional to $N^{1/3}$ while the area occupied by all interconnections and the corresponding routing capacity are both proportional to $N^{5/6}$. There also appears to be a maximum limit on the degree of integration, determined by that area and thus by the average linear dimension of a chip. Figures 5; references 5: 1 Russian, 4 Western.
[18-2415]

UDC 519.2

RELIABILITY OPTIMIZATION OF MULTIFUNCTIONAL SYSTEMS

Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian
No 3, May-Jun 83 (manuscript received 4 May 81) pp 62-69

GENIS, Ya. G. and USHAKOV, I. A., Moscow

[Abstract] A simple method is developed for optimizing the number of redundant components in a multifunctional system under constraints pertaining to hardware, software, and available capacity. A system consisting of m subsystems and performing r functions is considered with all the components of any one subsystem being identical. A subsystem is regarded as failing when the number of its failing components exceeds the number of redundant components in that subsystem and a function is regarded as missing when at least one subsystem in a group of $H_j = (i_1,\ldots,i_l)$ $(j = \overline{1,r};\ 1 \leq l \leq m)$ subsystems fails. The two redundancy problems considered are: 1) Find the number of redundant components which will minimize the weighted expenditures on ensuring given reliability characteristics; 2) Find the number of redundant components which will minimize the resultant functioning reliability of the system under constraints on expenditures (inverse problem). Computer time for solving these problems is saved by selecting an initial redundancy, whereupon the dominant sequence of redundancies and then the dominant subsequence of redundancies are established in accordance with certain stimpuations and a governing theorem. Both problems can be solved in a few iterations, the solution to each based on an applicable theorem and neither solution being necessarily unique. The procedure can be extended to problems with more selective constraints. The procedure is demonstrated on a system consisting of 6 subsystems and performing 3 functions where, with respect to reliability, the subsystems are connected in series and the components of each subsystem are connected in parallel. Proofs are given to all three theorems used in this method. Tables 2; references 5: 3 Russian, 2 Western (both in Russian translation).
[20-2415]

UDC 519.2

ONE PROBLEM OF PRODUCT SAMPLING

Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian
No 3, May-Jun 83 (manuscript received 5 May 81) pp 70-75

KARTASHOV, G. D. and SHVEDOVA, I. G., Moscow

[Abstract] One specific problem of product sampling is considered, namely determining the reliability indicators of products sampled from a lot on the basis of information F,Π,G obtained by test: $F(x) = P(X_0<x)$ the

distribution function of initial values X_0 of a technical parameter X, $G(t) = P(\xi<t)$ the distribution function of service time until failure ξ, $\Pi(x)$ the law of X_0 distribution. In order to solve this problem, it is necessary to know the conditional distribution $Q(t|x) = P(\xi<t\ X_0=x)$ representing the probability of failure at time t of samples with $X_0=x$. This conditional distribution cannot be determined uniquely but only estimated from the equation $\int_{-\infty}^{\infty} Q(t\ x)dF(x) = G(t)$ as $Q(t|x) = 1 - \Phi(\frac{m(t) - x}{u(t)})$, where Φ is the normal probability integral and m(t), u(t) are bilaterally bounded unknown functions. The problem is solved by considering the mean time between failures $T = \int_{-\infty}^{\infty} d\Pi(x) \int_0^{\infty} [1 - Q(t|x)]dt$ for the samples with distribution Π, namely calculating T_* and T* equal, respectively, to the infimum and the supremum of that integral with respect to time from 0 to t. The validity of this procedure rests on the absolute minimum and maximum of functional T being reached on functions $u_*(t)$ and u*(t), resectively. It is demonstrated by determination of $u_*(t)$ and u*(t) for normal distributions F(x) and $\Pi(x)$ with $\mu'<3\sigma$ and $\mu<3\sigma$, respectively. From the solution to this problem it is possible to establish what distribution $\Pi(x)$ must be to ensure that the selected samples will satisfy stimpulated requirements. Figures 2; references 7 (Russian).
[20-2415]

UDC 621.3.078

POLYNOMIAL APPROXIMATION OF PARAMETERS OF NONSTATIONARY SYSTEMS TO BE IDENTIFIED

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 26, No 6, Jun 83 (manuscript received 2 Apr 82) pp 35-38

PUPKOV, K. A. and SHMYKOVA, N. A., Moscow Institute of Electronic Machine Building

[Abstract] The problem is to identify a closed system $\dot{X} = f(X,U(X),P(t),t)$ where X denotes the n-dimensional state vector, U denotes the m-dimensional input vector, P(t) denotes the r-dimensional vector of parameters varying in time t. Approximating the components of the unknown vector P(t) with polynomials is proposed, on the a priori assumption that

$$P_i(t) = \sum_{n=0}^{N_i} a_{ni} - t^n \quad (\forall_t \varepsilon (t_0,T)) \quad i = 1,2,\ldots r \quad \text{are polynomial functions.}$$

The mathematical model of this system $\hat{\dot{X}} = f(\hat{X},U(\hat{X}),\hat{P}(t),t)$ is constructed so as to minimize the criterion $J = ||\hat{X}(t) - X(t)||_{Rn}$, by any conventional

method such as quasi-linearization. As the initial approximation it is most expedient to select the coefficients of a polynomial $p_i^0(t)$ such as a Chebyshev polynomial describing any selected function bounded within the P_i region. Such a representation of unknown coefficients facilitates solution of the identification problem with any desired accuracy. The algorithm of each successive approximation includes matrization, iteration, and successive linear regression. It is demonstrated on a second-order system $\dot{x}_1 = P(t)x_2^2(t)$

$\dot{x}_2 = -x_1 + U(x_1,x_2)$, with vector $Z(t_0) = [x_1(t_0),x_2(t_0),\alpha_0,\alpha_1,\alpha_2]^T$.

The paper was recommended by the Kafedra (Department) of Cybernetics. References 3: 1 Russian, 2 Western (both in Russian translation). [19-2415]

UDC 517.977:958:536.71

IDENTIFICATION OF INPUT PROCESSES TO SYSTEMS WITH DISTRIBUTED PARAMETERS

Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian
No 3, May-Jun 83 (manuscript received 23 Mar 81) pp 168-174

BORUKHOV, V. T. and KOLESNIKOV, P. M., Minsk

[Abstract] Inversion of linear dynamic systems with distributed parameters, broadly applicable to problems of automatic control, is considered for identification of inputs to an infinite-dimensional linear dynamic system with an unknown initial state. Specifically the method of left-hand inversion is applied to a system $\frac{\partial w}{\partial t} = Aw + Bu(t) + f$ invariant with respect to time shift (f- given function smooth with respect to t, u(t)- input signal, A- closed linear operator generating subgroup e^{At} of class C^0 in the real Hilbert space X of process states, B- linear operator acting from Euclidean space R^r into Hilbert space $D(A^*)'$, A^*- conjugate operator) and an output signal $y(t) = Cw + Du$ (C- bounded linear operator acting from space X of states into space R^m, D- linear operator of $R^r \to R^m$). The criteria of invertibility are established on the basis of four theorems pertaining to necessary and sufficient conditions. A typical identification problem is the reverse problem of thermal interaction, such as using the output signal from a semiopaque solid plate through which heat has propagated according to the law $\frac{\partial w}{\partial t} = \alpha\frac{\partial^2 w}{\partial x^2} + u_1(t)\frac{\varkappa}{c\rho}e^{-\varkappa x}$ for determining the flux density at time $t \geq 0$ of incident and boundary input radiation to that plate with unknown initial temperature distribution in it. References 17: 13 Russian, 4 Western (2 Russian in translation).
[20-2415]

UDC 621.315.616.9

NEW ELECTRICAL INSULATION MATERIALS BASED ON POLAR POLYMER FILMS AND ELASTOMER COATINGS

Moscow ELEKTROTEKHNIKA in Russian No 6, Jun 83
(manuscript received 3 Dec 82) pp 2-4

SHAPIRO, D. A., engineer, BASIN, V. Ye., doctor of chemical sciences, PETRASHKO, A. I., candidate of technical sciences, KHOFBAUER, E. I., candidate of technical sciences, SHAGALOV, S. B., engineer, TIGANINA, T. A., engineer, and YEROSHINA, Ye. Ya., engineer, All-Union Scientific-Research Institute of Electrical Insulation Materials

[Abstract] A set of two new electrical insulation materials has been developed, "synthoflexes" consisting of a polar polymer film and an elastomer coating. The polar polymer is polyethylene terephthalate or polyimide, a 0.04-0.05 mm thick film. The elastomer is partly vulcanized low-molecular organosilicon rubber, a 0.06-0.10 mm thick coating. The main advantage of this combination is a substantial improvement of the mechanical characteristics, namely higher strength and smaller shrinkage (2.5%) at 50°C higher temperature (130°C) than those of the substrate polymer alone. Experimental data indicate that the strengthening mechanism is inhibition of molecular mobility in the substrate by adhesive interaction of its surface with the coating. The synthoflexes have a thermal stability against decomposition (temperature of maximum decomposition rate), respectively higher and lower than that of polyethylene terephthalate and polyimide alone. The synthoflex based on polyethylene terephthalate is more important from the standpoint of practical use as a class C insulation material in tape form. Its monolithicity, unlike that of polyethylene terephthalate alone, changes only slightly during thermal aging. Figures 1; tables 4; references 7 (Russian). [17-2415]

UDC 621.315.61:620.172.251.28

NEW ELECTRICAL INSULATION MATERIALS WITH HIGH THERMAL ENDURANCE

Moscow ELEKTROTEKHNIKA in Russian No 6, Jun 83
(manuscript received 12 Nov 82) pp 5-8

ASNOVICH, E. Z., candidate of technical sciences, KOLCANOVA, V. A., candidate of technical sciences, and PUSTYL'NIK, M. L., candidate of chemical sciences, All-Union Scientific-Research Institute of Electrical Insulation Materials

[Abstract] Two new impregnating compounds SP-9, SP-20 and two new potting compounds AF-5-1, AF-8 have been developed for electrical insulation of generators and motors. Their main features are high thermal endurance, adequate for continuous duty at 300-600°C, and better mechanical or electrical properties as well as technological processing characteristics than those of corresponding older grades. They can also be produced more economically. Their properties begin to deteriorate rapidly at 700°C, but thermal aging at 850°C tends to stabilize them anew after a new phase composition is established with only a skeleton of the binder left. The impregnating compounds are suspensions of an inorganic filler (Al_2O_3) in an organosilicon binder. The potting compounds are pastes made of an aluminophosphate binder and an inorganic filler, suitable after hardening for continuous duty at 850°C in air, vacuum or inert gas atmosphere. There also have been developed two new groups of mica composites, namely micanites consisting of muscovite or phlogopite as filler in a phosphate binder and micaplasts consisting of muscovite or phlogopite as filler in a phosphate or organosilicon binder. A new laminated plastic is AGVN, suitable for 350°C, pressed asbestos paper impregnated with an organosilicon binder containing an inorganic filler. Figures 8; tables 6; references 5 (Russian).
[17-2415]

UDC 621.315.614.4

NEW ELECTRICALLY INSULATING LAMINATED PLASTICS

Moscow ELEKTROTEKHNIKA in Russian No 6, Jun 83
(manuscript received 6 May 82) pp 8-9

DULITSKAYA, G. M., engineer, ZININ, Ye. F., candidate of technical sciences, and CHAYKINA, Ye. A., candidate of chemical sciences, All-Union Scientific-Research Institute of Electrical Insulation Materials

[Abstract] Three new laminated plastics, Soviet equivalents of micarta, are compared with three textolite grades as electrical insulation materials. They are cold-stamped plain getinaks X, getinaks based on lavsan (dacron), and glass-getinaks with glass fibers as filler. They are found to be quite

competitive with textolite grades A, B, and high-frequency textolite with respect to mechanical and electrical properties as well as technological processing characteristics, even superior in terms of lower water absorption and higher moisture resistance. In rod and tube form they are also suitable as replacement for cotton-paper cloth plastics. Figures 2; tables 2.
[17-2415]

UDC 621.3.048:541.64.001.3

NEW ORGANIC BINDERS FOR ELECTRICAL INSULATION MATERIALS

Moscow ELEKTROTEKHNIKA in Russian No 6, Jun 83
(manuscript received 3 Dec 82) pp 10-12

ARSEN'YEVA, E. D., candidate of chemical sciences, AULOVA, N. V., candidate of technical sciences, KHOKHLOVA, G. V., engineer, SHIK, V. B., engineer, SHEGAY, E. R., engineer, and KOPCHENOV, V. I., engineer, All-Union Scientific Research Institute of Electrical Insulation Materials

[Abstract] Several organic binders for electrical insulation materials have been developed in the Soviet Union on the basis of hydrocarbon-phenolformaldehyde resins with chemical composition and structure similar to those of xylok produced in the United Kingdom by Albright-Wilson. Best characteristics were obtained with such a resin including fragments of diphenyl oxide and, as a hardener, hexamethylene tetramine, polyfunctional epoxy resin, or cycloaliphatic epoxy resin. These binders are used for producing glass-textolite in foil or tape form. They show excellent physico-mechanical properties, with a softening temperature not lower than 180°C. Figures 4; tables 3.
[17-2415]

UDC 621.315.616.001.5

MAIN TRENDS IN PRODUCTION AND STUDY OF ELECTRICAL INSULATION MATERIALS

Moscow ELEKTROTEKHNIKA in Russian No 6, Jun 83
(manuscript received 3 Dec 82) pp 12-14

ZININ, Ye. F., candidate of technical sciences, KONOVALOV, V. V., candidate of chemical sciences, DULITSKAYA, G. M., engineer, and PANIN, A. L., engineer, All-Union Scientific-Research Institute of Electrical Insulation Materials

[Abstract] Glass-plastics play a major role in insulation materials suitable for modern electrical power equipment with ever increasing per-unit capacity. At the All-Union Scientific Research Institute of Electrical Insulation Materials glass-plastics for electrical insulation are studied

and produced along three main lines: 1) glass-plastic sheet based on cloth (textolites) with high thermal endurance, heat resistance, fire resistance, and mechanical strength; 2) glass fibers molded in resin, non-arcing and non-tracking with best possible mechanical and electrical properties; 3) fabricated glass-plastics for wedges, spacers, cleats, etc. Epoxy resins and organosilicon resins are used increasingly as binders with excellent properties and technological characteristics. The basic objectives are to improve the technology of producing electrical insulation with maximum economy of materials and labor, to attain maximum utilization of their characteristics, and to find suitable replacements for scarce raw materials. The quality of new Soviet-made electrical insulation materials must and is compared with that of corresponding foreign-made ones, which requires a great deal of effort and expense on testing methods and equipment. Specific research projects include study of the kinetics of glass-plastics restructurization caused by various aging agents, accumulation of reliable factual data on each grade of material developed under conditions of its intended use, determination of the thermal endurance parameters such as deformation and decomposition temperatures, and development of a fast method of determining the parameters in the Zhurkov equation. Tables 4; references 12 (Russian).
[17-2415]

UDC 621.315.616.97:66.018.86

RADIATION RESISTANCE OF ELECTRICALLY INSULATING CAST POLYURETHANE COMPOUNDS

Moscow ELEKTROTEKHNIKA in Russian No 6, Jun 83
(manuscript received 3 May 82) pp 14-16

MASLOV, V. V., candidate of technical sciences, MAKAROVA, N. V., engineer, SILANT'YEV, V. A., engineer, STAROSTINA, T. P., engineer, and TRONIN, B. A., engineer, All-Union Scientific Research Institute of Electrical Insulation Materials

[Abstract] Two new cast polyurethane compounds for electrical insulation have been tested for resistance to ionizing radiation. The first compound has a VILAD 13-1 formulation with talc filler. The second compound is a modification of the first one by epoxide-dianic resin. Specimens 4 mm thick and 5 mm wide, total length 80 mm and gauge length 43 mm, were placed in a linear accelerator and bombarded with 1.6 MeV electrons without heating above 50°C. Their electrical properties (breakdown voltage, dielectric loss tangent) and mechanical properties (tensile strength, yield point strain) were measured by standard methods in the initial state and after various irradiation doses, 6 specimens used for electrical tests and 10 specimens used for mechanical tests. The doses of absorbed radiation were determined according to the rules of additivity, chemical composition and physical mix. An evaluation of the data on the basis of the Bethe-Block relation for ionization loss indicates that the modified second compound has a higher resistance. It retains its electrical properties under radiation doses up to $1 \cdot 10^9$ rad and its mechanical properties under

radiation doses up to $1 \cdot 10^{10}$ rad (tensile strength) or $8 \cdot 10^{8}$ rad (yield point strain). Both compounds rank as electrical insulation materials with top radiation resistance, even higher than that of polystyrene and of phenol-formaldehyde with asbestos filler. Figures 3; tables 1; references 10: 7 Russian, 3 Western (2 in Russian translation).
[17-2415]

UDC 621.315.61.001.4

ACOUSTIC EMISSION AS CRITERION FOR ESTIMATING STATE OF ELECTRICAL INSULATION DURING FATIGUE TESTS

Moscow ELEKTROTEKHNIKA in Russian No 6, Jun 83
(manuscript received 20 Jul 82) pp 17-19

ARONSHTAM, Yu. L., candidate of technical sciences, KAMENETSKIY, A. O., engineer, KARPOVA, G. I., engineer, KUDRYAVTSEVA, G. A., engineer, PODOL'SKAYA, G. V., engineer, and FREYEROV, V. O., engineer, All-Union Scientific Research Institute of Electrical Power Engineering and Scientific Research Institute at Leningrad Economic Planning Department "Elektrosila"

[Abstract] Two series of experiments were performed in order to determine the state of electrical insulation under cyclic loads without high-voltage testing. In the first series the effect was studied of changes in the natural frequency of specimens, characterizing the level of their defectiveness, on the parameters of changing acoustic emission and life expectancy. From the results of these the minimum decrement was estimated of insulation life expectancy recordable by the method of acoustic emission. In the second series changes were recorded in the count rate of acoustic emission pulses as function of time, for the purpose of establishing whether acoustic emission can be used as a criterion for checking insulation breakdown. Specimens of thermosetting insulation in the form of impregnated tape built up to a bar were tested in cyclic flexure, 3 mm thick bars mounted in cantilever fashion and1.5 mm thick bars mounted on two supports. The initial strain amplitude at the surface of these specimens was set at $1 \cdot 10^{-3}$, corresponding to that in a typical generator during transients. The ratio of initial to final natural frequency was measured after various time intervals (numbers of load cycles), while the cumulative number of acoustic emission pulses was also recorded. For control, the specimens after these tests were also tested electrically in fields of 15 and 13 MV/m (3 mm thick specimens) or 11 MV/m (1.5 mm thick specimens). According to the results of this experimental study, acoustic emission and changes in its parameters can serve as an indicator and criterion of the state of electrical insulation, its level of defectiveness and life expectancy during mechanical-electrical fatigue tests. Figures 4; tables 1; references 7 (Russian).
[17-2415]

UDC 621.315.616.9.019.33.001.4

THERMAL SHOCK RESISTANCE OF INSULATING COMPOUNDS

Moscow ELEKTROTEKHNIKA in Russian No 6, Jun 83
(manuscript received 3 May 82) pp 19-22

GOLUBKOV, G. Ye., candidate of technical sciences, and SAVEL'YEVA, L. N., engineer, All-Union Scientific Research Institute of Electrical Insulation Materials

[Abstract] Insulation in cryogenic electrical equipment is subject to thermal shocks, its capacity to absorb and withstand them depending on its geometry and thermoelastic properties including the relaxation time. The thermal shock resistance of 19 insulating compounds (epoxies, polyurethane, polymethyl methacrylate among them) was studied experimentally, parallelepipedal and spherical specimens of various sizes having been selected for this purpose on account of their relatively small form factor and large surface-to-volume ratio. The tests were accelerated by staging them in four successively more severe heating-cooling cycles. Accordingly, the specimens were heated 1) in air at room temperature, 2) in water at room temperature (18-23°C), 3) in boiling water (100°C), 4) in an organosilicon fluid (150°C) and quenched in liquid nitrogen (77 K) each time. A theoretical interpretation of the test results and their correlation with heat transfer and thermal stability data has yielded tentative values for a generalized coefficient of thermal shock resistance characterizing each of these 19 compounds. The study has revealed that the resistance decreases with increasing severity of thermal shock and with increasing size of specimens, that compounds with filler have a higher resistance to thermal shock than compounds without filler, and that this resistance of epoxy compounds is raised by addition of an accelerant and by annealing while it is lowered by addition of a hardener which increases the elasticity. Figures 2; tables 2; references 7: 5 Russian, 2 Western (in Russian translation). [17-2415]

UDC [621.333:621.315.616.97].001.41

EXPERIENCE IN OPERATION OF TRACTION MOTORS WITH GLASS-MICA FIBER AND EPOXY THERMOSETTING INSULATION

Moscow ELEKTROTEKHNIKA in Russian No 6, Jun 83
(manuscript received 9 Aug 82) pp 23-24

YERSHOV, D. P., engineer, Novocherkassk Electric Locomotive Manufacturing Plant

[Abstract] In the nineteen sixties a new insulation system was introduced into locomotive traction motors, namely glass-mica fiber with polyester or

epoxy binder, which ensured better heat transfer and higher moisture resistance than the existing varnished glass-mica tape insulation. This new insulation system was subsequently tested during the 1969-80 period for an evaluation of its resistance to atmospheric effects under operating conditions. As the test object had been selected the armature of an NB418k6 motor with Monolit-2 insulation containing an epoxy compound. During the first 2 years the daily, 10-day, and monthly average air temperatures and humidity were recorded. The daily, 10-day, and monthly average insulation resistance (electrical) were recorded throughout the entire 11-year period. The state of the insulation was checked twice a day, by visual inspection and by using a Megger high-range ohmmeter with a voltage of 6.5 kV to "ground", its initial resistance before the test having been 10,000 Mohm. The insulation resistance was found to change directly following changes in the precipitation level, this correlation being closest in autumn on account of the level of surface moisture on the insulation becoming most firmly stabilized by overall weather conditions during these months. After the first year of climatic tests the insulation resistance had dropped to 35 Mohm. It was subsequently restored to its initial level by cooling at 20°C after heating and drying at 160°C (during which it first dropped to 0.04 Mohm and then rose to 0.65 Mohm at 155°C). After the second year of tests the insulation resistance had dropped to 29 Mohm, without evidence of cracks in the insulation. It was again restored to 10,000 Mohm for the following tests. In another test 89 of these motors produced in 1969-70 were run 400,000 km before the first overhaul. Only five of them could be further monitored: one running a total of 750,000 km, one running of a total of 900,000 km, and these running a total of over 1,000,000 km. Figures 3.
[17-2415]

UDC 621.315.61:678.026.34:621.315.14

COMPARATIVE CHARACTERISTICS OF POLYMER MATERIALS FOR INSULATION OF CURRENT-CARRYING BUSBARS BY SPRAY METHOD

Moscow ELEKTROTEKHNIKA in Russian No 6, Jun 83
(manuscript received 26 Oct 82) pp 24-26

VARDENBURG, A. K., doctor of technical sciences, PILIPOSYAN, P. M., candidate of technical sciences, and TYSYACHNIK, O. N., engineer, OVHIIEM (expansion unknown. It may have something to do with the All-Union Scientific Research Institute of Electrical Insulation Materials)

[Abstract] A series of epoxy powders EVN-6,23,10M is now produced for insulation coating of current-carrying busbars and power distribution panels by the vibro-whirling spray process, three color modifications of EVN-6 (EVN-6Ts with red, yellow, blue pigments respectively) also being available. This type of insulation offers several advantages, mainly it permits reducing the size of equipment and thus improving the economy of active metal without degradation of reliability and safety. The thickness of the deposited coating depends on the parameters of the polymerization process,

it increases at a decreasing rate with an increasing length of time and at an increasing rate with increasing temperature. The critically important characteristics of insulation materials for such an application are their resistance to mechanical impact and resistance to thermal shock. A comparative evaluation of these characteristics as well as basic thermophysical and electrophysical properties, on the basis of qualification tests including accelerated thermal aging (static at 180°C, cyclic at 150-190°C), reveals that all the EVN epoxies are as good as or better than the 6/91/33 powder produced by Helique Cie (France). They also meet all requirements with respect to which EP epoxies are deficient. Their life expectancy at 130°C is 30-40,000 h. While all three EVN epoxies have similar thermophysical and electrophysical properties, also high moisture resistance, mechanically EVN-23 is the best and EVN-10M a near second. Figures 3; tables 3; references 2 (Russian).
[17-2415]

UDC 621.315.61.34

NEW APPROACH TO ESTIMATING THERMAL ENDURANCE OF ELECTRICAL INSULATION MATERIALS AND TO THEIR CLASSIFICATION ON THIS BASIS

Moscow ELEKTROTEKHNIKA in Russian No 6, Jun 83
(manuscript received 15 Dec 82) pp 28-30

PETRASHKO, A. I., candidate of technical sciences, and KRAVTSEVA, I. I., engineer, All-Union Scientific Research Institute of Electrical Insulation Materials

[Abstract] In publications IEC 85 as well as in the CEMA 782-77 standard and USSR GOvernment STandard 8865-70, electrical insulation materials are classified with respect to thermal endurance on the basis of chemical composition. Treating this classification as a preliminary guideline, the later publication IEC 216 classifies electrical insulation materials in this way, using two characteristics of thermal endurance: temperature index and thermal endurance range. The latter is coded in three numbers, each of which represents a temperature in °C on the thermal endurance diagram. The first number is the temperature index obtained by extrapolation of the curve to a 20,000 h insulation life. The second number is the temperature which corresponds to a 5000 h insulation life and the third number is the lower limit of its 95% confidence interval. All three numbers are based on statistical reliability analysis of test data. These classification criteria are being further discussed and revised, in the light of more extensive studies. Typically, tapes of glass-mica fiber and binder compounds with matching heat treatment for generator and motor coils have been tested for the thermal endurance range, with the temperature index numbers referring to: 1) change in mechanical (tensile) stress during flexure; and 2) change in electric strength (breakdown voltage). Still another characteristic of thermal endurance is proposed for consideration, namely "doubling (or halving) interval": distance on the axis of abscissas on the thermal endurance diagram between two points which correspond to

lengths of life differing by a factor of 2. Some data pertaining to this characterizing and classifying parameter have already been obtained for LKhM varnished cloth and for cotton-paper cloth with oil varnish impregnation. Figures 1; tables 2; references 4: 2 Russian, 2 Western.
[17-2415]

UDC 621.315.61:536.495:620.181.4

APPLICATION OF METHODS OF THERMAL ANALYSIS OF QUALITY CONTROL OF ELECTRICAL INSULATION MATERIALS AND ACCELERATED ESTIMATION OF THEIR THERMAL STABILITY

Moscow ELEKTROTEKHNIKA in Russian No 6, Jun 83
(manuscript received 15 Dec 82) pp 30-33

BEBCHUK, T. S., candidate of technical sciences, All-Union Scientific Research Institute of Electrical Insulation Materials

[Abstract] Thermal stability (stability of electrical and mechanical properties at high temperatures) is defined as a synonym of thermal endurance (ability to retain chemical constitution at high temperatures), with the reservation that the former is included in and necessary but not sufficient for the latter. Thermal stability is determined with the aid of thermal analysis, in theoretical and scientific research as well as in engineering empirical or semiempirical study of insulation life and allowable operating temperatures. For quality control of electrical insulation materials and for accelerated estimation of their thermal stability by thermal aging can be considered all four known basic methods of thermal analysis: differential thermal analysis, microcalorimetry (differential scanning or isothermal differential), thermomechanical analysis, and thermogravimetric analysis. Typical examples of application of one or another preferable method are differential scanning calorimetry for determination of the degree of hardening. Thermomechanical analysis for determination of glass transition temperature and thermal expansion coefficients, thermogravimetric analysis for determining the amount of solvent residue and the effect of additives, isothermal differential calorimetry for determination of reaction speed, with gas chromatography for determination of reaction products, and isothermal thermogravimetry for sensitive determination of aging rate. It is recommended that thermograms of a tested material be recorded at several heating rates. References 19: 7 Russian, 11 Western (1 in Russian translation), 1 IEC.
[17-2415]

UDC 621.316.923.1.001.3

DEPENDENCE OF ARCING PROCESSES IN PROTECTIVE FUSE ON DENSITY OF QUARTZ FILLER

Moscow ELEKTROTEKHNIKA in Russian No 8, Aug 83
(manuscript received 5 Sep 82) pp 36-37

NAMITOKOV, K. K., doctor of technical sciences, and FRENKEL', Z. M., engineer, Kharkov Institute of Municipal Construction Engineering

[Abstract] An insufficiently high density of the quartz filler is a major cause of malfunctioning of protective fuses. An experimental study was made to determine the dependence of arcing processes and fuse performance characteristics on the density of that filler. Tests were performed in a special box of 8 mm thick rectangular Textolite plates, with an inside length of 100 mm and cross section of 26 x 28 mm^2. Both copper and aluminum foils 0.14 mm thick and 10 mm wide with a 1 mm long neck, respectively 1.5 mm wide (copper) or 2.5 mm wide (aluminum at the center, were tested in a 500 V d.c. circuit (time constant 2.3 ms) carrying a current of 1230 A. Electrical measurements were made with an oscillograph and a Hall probe. The pressure on the fuse shell was measured with a special displacement and vibration transducer measuring the change of frequency in the tank circuit of a high-frequency oscillator upon a change of distance from the instrument extension-wire inductance to the conductor surface and converting this change of frequency to a change of voltage. The fuse shell was filled with sand containing at least 99% SiO_2 with a mean grain size of 0.21 mm (density 1.62 g/cm^3), a 51% fraction of 0.16-0.2 mm grains, a 10% fraction of grains smaller and a 39% fraction of grains larger. The sand inside the shell was gradually compacted to a maximum density of 1.75 g/cm^3. The results of measurements reveal how the pressure on the shell walls depends on the density of the filling sand. During the arcing process the increase of density and pressure predominates first, but thereafter the more intense heat dissipation from the arc and the consequent dropping of its temperature predominate. Optimum shell resistance to fracture is obtained with a filler density of at least 1.74 g/cm^3 for fuses without overvoltage limitation. In fuses with overvoltage limitation special measures are required so as to lower the overvoltages and ensure adequate arc quenching. Figures 3; references 4 (Russian).
[9-2415]

UDC 581.51:519.87

METHODOLOGY OF SYSTEM SIMULATION FOR ESTABLISHMENT OF RATIONAL PRODUCT LIST OF PIEZOELECTRIC INSTRUMENT TRANSDUCERS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 26, No 6, Jun 83 (manuscript received 7 Aug 82) pp 9-13

ALEKSANDROV, V. K.,and SHMAKOV, E. M., Leningrad Polytechnic Institute imeni M. I. Kalinin

[Abstract] Rationalization of the product list of instrument transducers is treated as a problem of mathematical programming for a combination of discrete and continuous structures. The problem is defined as one of determining from the complete set of possible transducer types the final set which will cover the entire range of performance characteristics at the minimum production cost. The procedure involves system simulation and successively solving three interrelated problems: 1) Extract the basic classes from the total set of transducer types; 2) Determine the extreme values of the performance characteristics for each basic class; and 3) Determine the types to be included in the final product list. The first problem is solved by applying the method of morphological analysis to a functional transducer system. The second problem is solved by applying the method of conditional parametric optimization to the extracted transducer classes. In the case of piezoelectric transducers their performance characteristics refer to mass, conversion factor, frequency of fundamental vibration mode, and the upper limit of measurement range. The target function is selected so that all other characteristics will lie on the surfaces of Pareto-optimum solutions. For illustration, this procedure is applied to a set of eight most typical piezoaccelerometer structures. Upon comparative evaluation of four extracted classes (two types in each), including simulation of the frequency dependence of the upper limits of their measurement ranges, the product list is found to require only 5-6 types for covering the entire performance range. The paper was recommended by the Kafedra (Department) of Information-Measuring Technology. Figures 2; references 5 (Russian). [19-2415]

UDC 621.317.41

CALCULATION OF ELECTROMAGNETIC FIELDS IN TRANSFORMER-TYPE DISPLACEMENT TRANSDUCERS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 26, No 6, Jun 83 (manuscript received 24 Aug 82) pp 3-8

KONYUKHOV, N. Ye., SKVORTSOV, B. V. and KURITSKIY, A. A., Kuybyshev Institute of Aviation imeni S. P. Korolev

[Abstract] A cylindrical displacement transducer with a shell-type transformer construction is considered, with an outer wide stationary excitation coil and an inner narrow axially movable magnetizing coil. A ferromagnetic cylindrical bushing underneath the measuring coil is slipped on the shaft to form the inner housing wall and a ferromagnetic cylindrical sleeve coaxial with the bushing and equally long surrounds the excitation coil to form the outer housing wall. This cylindrical housing is closed at both ends by flat ferromagnetic lids. The two coils are separated by a ferromagnetic cylindrical spacer, coaxial with and between the two housing walls. The excitation coil is, furthermore, mechanically split by a ferromagnetic washer into two identical sections side by side which are electrically connected in series-opposing. Any movement of the measuring coil from its neutral (symmetric) position relative to the bisectional excitation coil will produce a voltage of an amplitude proportional to the displacement. In order to determine the performance characteristics of this device, it is necessary to calculate its electromagnetic parameters on the basis of the field distribution over the entire space inside the housing. This is done on the basis of a two-dimensional model where each component of the ferromagnetic structure constitutes a field boundary and the magnetic permeability of the ferromagnetic material has been assumed to remain constant. With an equivalent magnetic circuit replacing the structure and a thin layer as a seat of mmf replacing the excitation coil, the field equation for the magnetic scalar potential is formulated in a cylindrical system of coordinates and solved by the method of finite differences with the aid of an approximating grid. By virtue of symmetry, only one quarter of the structure needs to be considered. The structure is subdivided into elements of simple geometry with easily evaluated magnetic reluctances and boundary potentials. The calculations have been programmed in FORTRAN-4 for a YeS-1022 Unified System digital computer. Calculations for a transducer with typical values of design and performance parameters indicate that the magnetic leakage flux can reach 65% of the total magnetic flux. Taking the leakage flux into account accordingly should improve the accuracy of calculations by 20%. The paper was recommended by the Kafedra (Department) of Radio Engineering. Figures 4; references 7: 5 Russian, 2 Western (both in Russian translation).
[19-2415]

UDC 621.382

FUNCTIONAL SIGNATURE INSPECTION OF MICROCIRCUITS IN REPROGRAMMABLE READ-ONLY MEMORIES WITH ULTRAVIOLET CLEANING

Moscow MIKROELEKTRONIKA in Russian Vol 12, No 5, Sep-Oct 83
(manuscript received 28 Jun 82) pp 464-471

NOVIK, G. Kh., All-Union Scientific-Research Institute of Electromechanics

[Abstract] Functional inspection by the signature method using trivial test signals is a simple way to check logic microcircuits of reprogrammable read-only memories, in the unprogrammed state as well as with programmed packages, for retention of recorded data. A memory microcircuit is, for the purpose of inspection, regarded as a combinatorial one with extra access permit/inhibit inputs. A signature analyzer is described here which also checks for a "clear field" and for correct operation of the "access permit" inputs. This is made possible by a special design of the memory output stage, with a pair of MOS transistors connected in series and operating in push-pull, and by a multiplexer in the analyzer with a TTL gate at each input sensing the Z-state as logic "1". The inspection time window consists of 4096 cycles, its first half for a START signal and second half for a STOP signal, the period of each half divided equally between "permit access" and then "inhibit access" sampling of all addresses. The binary output vector during the "permit access" half-period and during the "inhibit access" half-period is shown for a correct microcircuit as well as for various modes of microcircuit fault (no "permit", no "inhibit), also in the case of over-coding, in accordance with respective signatures. Figures 6; references 5: 4 Russian, 1 Western.
[18-2415]

UDC [621.313.2:621.3.047.43].001.1

OUTLOOK FOR USE OF SLIDING CONTACT MADE OF CARBON FIBERS

Moscow ELEKTROTEKHNIKA in Russian No 8, Aug 83
(manuscript received 4 Oct 82) pp 42-44

FIALKOV, A. S., doctor of technical sciences, ZAYCHIKOV, V. G., candidate of technical sciences, PLATOV, V. S., candidate of technical sciences, and TITOV, V. G., engineer, VNIIEI (Expansion uncertain. Possibly All-Union Scientific-Research Institute of Electrical Engineers]

[Abstract] The characteristics of commutator brushes made of carbon fiber are analyzed from the standpoint of advantages of such brushes over metal-graphite and electrographite ones in terms of current and voltage ratings. Such a carbon fiber is produced by high-temperature treatment of polyacrylonitrile, tar and viscose fibers, it is 80-20 μm in diameter and has excellent mechanical properties, high strength and elasticity, as well as a high degree of anisotropy of electrical resistivity. That of the VEN-280 grade is 6 μohm.m in the longitudinal direction and much higher in the transverse direction. Metallization with copper or nickel lowers the electrical resistivity in the direction of current flow, while parallel bundling of fibers in this composite material lowers it further and increases it in the transverse direction. Such brushes, designed in various shapes and sizes without or with cover slab, can carry currents of up to 200 A/cm^2 at voltages of 3.5-4V per pair under a typical pressure of $1.478 \cdot 10^{-4}$ Pa. Specimens have also been tested for friction and wear, the former being relatively high because of lacking self-lubrication capability but the latter being very low at moderate current densities. One problem with the use of these brushes is formation of thick films of copper oxide on the commutator surface. Figures 5; references 4: 2 Russian, 2 Western. [9-2415]

UDC 621.337:62-592.2.001.24

DESIGN OF HYDRAULIC BRAKE FOR DRIVE OF D.C. POWER SWITCH

Moscow ELEKTROTEKHNIKA in Russian No 8, Aug 83
(manuscript received 25 Nov 82) pp 33-35

GRIBKOV, A. M., engineer, YEMTSEV, B. T., doctor of technical sciences, and SMOLYAK, A. I., candidate of technical sciences, MEI (Moscow Power Engineering Institute)

[Abstract] A hydraulic brake has been designed for a d.c. power switch driven by a differential piston moving under gas pressure through a cylinder filled with fluid, this cylinder having axial slots which allow the fluid to flow out freely from under the moving piston. When the slots are covered by the small piston head while the latter moves into the surge chamber, whose wall constitutes the stationary switch contactor, a sharp pressure rise in that chamber causes the movable contactor closing the chamber to slide. The braking devide is a cap on the small piston head consisting of a cylindrical segment and a conical one, the latter forming with the nozzle an annular clearance-orifice of a length equal to the piston travel in addition to the other clearance-orifice formed by the small piston head underneath and the cylinder. The performance calculations are based on the equation of motion for the piston and the equation of continuity for the fluid in the surge chamber. Pressure of the fluid on the spherical tip of the cap and on the back side of the piston are assumed to be negligible, while pressure of the driving gas is assumed to remain constant during the process. The flow of the fluid through the orifices is designed to be laminar, with the Reynolds number $N_R \leq 500$. The resolvent first-order differential equation for the rate of change of pressure in the surge chamber has been solved by the Runge-Kutta method on a "Nairi-2" computer. On the basis of the solution the parameters have been determined of the braking process, namely piston displacement and piston velocity as well as fluid pressure, as functions of time. The design parameters (piston and cap dimensions, widths of clearances, gas pressure, viscosity of brake fluid) have been selected accordingly to ensure a much better efficiency and reliability than that of a mechanical brake with damper for repeated operations. Figures 5; tables 1; references 3 (Russian). [9-2415]

UDC 621.313.322-81:62-784.62.001.3

SHIELDING MAGNETIC FIELD IN END ZONE OF LARGE TURBOGENERATORS

Moscow ELEKTROTEKHNIKA in Russian No 8, Aug 83 (manuscript received 10 Jan 82) pp 13-16

KHUTORETSKIY, G. M., doctor of technical sciences, and KOSACHEVSKIY, V. I., candidate of technical sciences, LPEO "Elektrosila" [Leningrad Economic Planning Department "Elektrosila"]

[Abstract] Shielding the magnetic field in the end zones of large turbogenerators is one way to decrease additional heating and power losses caused by the magnetic leakage flux. This method was evaluated comparatively with other methods concurrently employed for this purpose such a beveling the end stacks and spliting the teeth, use of nonmagnetic steel or nonmetallic materials for purely structural components of the machine, and optimization of the cooling system. In one experiment an electric shield made of a high-conductivity material (copper) so that eddy currents induced in it by the axial leakage flux would produce a magnetic flux opposing the latter, was inserted between the end stack and the retaining plate on one side, the turbine side, of a 160 MW - 3000 rpm industrial turbogenerator. In another experiment a magnetic shunt consisting of two separated stacks and a damping shield was also inserted between the end stack and the retaining plate on the other side of the generator, in a 160 MW - 3000 rpm machine and in a 1000 MW - 1500 rpm machine, so as to ensure maximum coverage of the stator core face and minimum overheating of the stator teeth. The performance of these shielding devices was tested with the machines running from no load to full load, at constant nominal active load and either an inductive load corresponding to 0.826 power factor or a capacitive load corresponding to 0.903 power factor. Measurements of temperature and magnetic flux distributions have revealed that such a combination of shielding devices can reduce the magnetic leakage flux to one half or even one third with a corresponding increase of the temperature margin and overload capacity, especially during underexcitation of the machine. Figures 5; references 4: 3 Russian, 1 Western.
[9-2415]

UDC 621.311.6

CHOICE OF STRUCTURE OF SECONDARY ELECTRICAL SUPPLY SOURCE

Moscow ELEKTROSVYAZ' in Russian No 8, Aug 83 (manuscript received 10 Apr 81) pp 48-50

ARTAMONOVA, O. M.

[Abstract] A functional-nodal method of design is used during development of unified sources of secondary electrical supply (SSES). In so doing the

complex circuit involved is divided into a series of functional units, examples of which are identified. The problem of optimizing the parameters of SSES is considered. As an example the problem is examined of optimizing the structure of a pulse voltage regulator with a parallel switch and a series choke, during operation in a range of powers up to 400 Watt. Figures 2; tables 1; references 7: 6 Russian, 1 Western (in Russian translation).
[30-6415]

UDC 621.311.6.001.24

THEORY-GAME METHOD OF DECISION MAKING DURING OPTIMIZATION OF SYSTEMS OF SECONDARY POWER SUPPLY

Moscow ELEKTROSVYAZ' in Russian No 8, Aug 83 (manuscript received 7 Apr 82) pp 45-48

KRIVOZUBMOV, V. P.

[Abstract] The over-all complexity of contemporary systems of secondary power supply (CSPS) makes their analysis difficult, especially with respect to rational decision making during the development of a CSPS structure and finding optimum parameters. Use of the theory-game methods of decision making for the solution of the multicriterional and multipurpose problems which arise during analysis and optimization of CSPS is described. Such methods have found wide circulation in the solution of technical-economical problems, the goal of which is the distribution of resources in an optimum manner. Figures 2; references 6: 5 Russian, 1 Western (in Russian translation).
[30-6415]

UDC 621.612.387.84

DEPENDENCE OF RESOLUTION OF ELECTRON-OPTICAL CONVERTERS IN VIEWING SYSTEMS ON SPECTRAL CONTENT OF INTENSIFYING RADIATION

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 26, No 6, Jun 83 (manuscript received 23 Jun 82) pp 77-80

GVOSDEV, S. M. and ROMANOV, S. S., Moscow Power Engineering Institute

[Abstract] The method of spatial selection is effectively used for viewing objects in semiopaque or turbid media, with the aid of a monochromatic flash source which provides intensification of light of the proper wavelength. The receiver performance in terms of detection, discrimination, and recognition depends largely on the resolution of the electron-optical converter. That resolution is determined, among other things, by the wavelength of incoming radiation and thus on the spectral content of the latter. In order to match the receiver and the intensifier optically, it is necessary to determine first the scattering indicatrix of the converter as well as the velocity distribution and the exit-angle distribution of electrons at its photocathode. This has been done in an experimental study for a single-camera electron-optical converter with ring shutter and polyalkaline photocathode. Its resolution was measured under a microscope with 32x magnification, and the brightness of its screen was measured with a VFM-57 low-intensity photometer and held constant at 60 cd/m^2. The test equipment included a KGM-12-75 halogen lamp illuminating a generator of optical pulses, and three VEB Karl Zeiss (Jena) interference-type filters to pass light in the 478$\pm$9 nm, 575$\pm$6 nm, 625$\pm$6 nm bands respectively. For reference, the lamp was also operated as an "A" source. On the basis of the data, not only the dependence of the converter resolution on the intensifier wavelength was established, but also the dependence of the maximum resolution on the focusing bias voltage and thus the optimum focusing bias voltage for a given wavelength. The paper was recommended by the Kafedra (Department) of Lighting Engineering. Figures 2; tables 1; references 4: 3 Russian, 1 Western.
[19-2415]

UDC 621.372.632

EFFICIENT NUMERICAL METHOD OF CALCULATING CAPACITANCES PER UNIT LENGTH IN MULTICONDUCTOR MICROSTRIP LINE

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 8, Aug 83 (manuscript received 7 Jun 82) pp 5-9

MUSHENKO, SERGEY VASIL'YEVICH, candidate of technical sciences, docent, and LABYNTSEV, ALEKSEY VIKTOROVICH, student, Taganrog Institute of Radio Engineering

[Abstract] A numerical method of calculating the capacitances per unit length of multiconductor microstrip lines is proposed, one that is not only universal but also economical. It is based on solving the Laplace equation for the electric potential with appropriate boundary conditions and then approximately solving an integral equation of the first kind for the surface charge density along the center conductors of such a line. It is demonstrated on a typical microstrip line consisting of three center conductors and two layers of dielectric filler. After separation of variables and expansion into Chebyshev polynomials, the resulting N series are reduced to 3N linear algebraic equations in coefficients of those polynomials (3 center conductors, N terms in Chebyshev series). The solution converges rapidly and, therefore, is economical in terms of computer time. A comparison with an analytical solution indicates that its error does not exceed 1% and decreases rapidly with increasing N. Figures 1; tables 1; references 4 (Russian). [21-2415]

UDC 621.316.73:681.325.005

SYNTHESIS OF STABILIZATION SYSTEM FOR MAGNETIC SUSPENSION

Moscow ELEKTROTEKHNIKA in Russian No 6, Jun 83
(manuscript received 2 Jun 82) pp 43-46

KRAPIVIN, V. S., candidate of technical sciences, NIAT (Scientific-Research Institute of Automobile Transportation)

[Abstract] A stabilization system for magnetic suspensions of instruments or vehicles is considered which will remain invariant under signal or parameter perturbations of large amplitudes. The theoretical analysis is based on the mathematical model of a single-stage axisymmetric suspension consisting of an electromagnet and the ferromagnetic object which is made to levitate, a set of two differential equations: equation of motion and equation of the circuital law. The desirable dynamic behavior in terms of motion corresponding to optimum response speed is defined as a reference for the solution of these equations. The control algorithm utilizes the principle of localization, with slip modes and self-excited high-frequency oscillations put in safe ranges. The stabilizer structure synthesized accordingly contains a presetter of desirable dynamic parameters in the equation of motion, a differentiator, a comparator, a displacement transducer, and a mismatch signal amplifier with an either subdiscontinuous or discontinuous characteristic. The steady-state stabilization error can be reduced to zero, without reduction of immunity to perturbations, by allowing small self-excited high-frequency oscillations and connecting an integrator as a correcting device in parallel with the amplifier. The performance of such a stabilizer is that of a system with separate "fast" and "slow" motions. When even small self-excited high-frequency oscillations are not permissible, then a stablizier structure with a continuous control characteristic is preferable and a corrector with a transfer function $W_k(p) = k_1/p$ is connected in parallel with the subdiscontinuous amplifier. An experimental stabilization system based on these principles, with specific design parameters and performance requirements, was tested with continuous control (static steady-state) and with discontinuous control (dynamic steady-state). In the latter mode the system was less critically sensitive to self-excited high-frequency oscillations as well as to signal or parameter perturbations and to unaccounted for inertias. Figures 4; references 4 (Russian).
[17-2415]

UDC 629.439

ADAPTIVE REGULATOR OF AIR GAP IN ELECTROMAGNETIC SUSPENSION

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA
in Russian No 8, Aug 83 (manuscript received 20 Apr 83) pp 110-113

NIKITENKO, YURIY ALEKSANDROVICH, graduate student,
TUSHKANOV, NIKOLAY BORISOVICH, candidate of technical sciences, assistant,
SAVIN, MIKHAIL MIKHAYLOVICH, candidate of technical sciences, docent, and
MANIKHIN, ALEKSANDR IVANOVICH, junior scientist, Novocherkassk Polytechnic Institute

[Abstract] An electromagnetic suspension is considered, where horizontal movement of the electromagnet parallel to the rail surface above it induces eddy currents in the latter which reduce the lift force. Laminating the rail reduces this effect but increases the cost. Therefore an automatic regulator of the air gap between electromagnet and rail is examined, the dependence of its performance on the decrease of the lift force being analyzed according to the theory of automatic control. On the basis of the force-current-gap relation $F = K_I I - K_\delta \delta$ (F- force, I- current, δ- gap width, $K_f = \frac{\partial F}{\partial I}\Big|_{\delta_n, I_n}$ and $K_\delta = \frac{\partial F}{\partial \delta}\Big|_{\delta_n, I_n}$, I_n- nominal current δ_n- nominal width of air gap), an adaptive automatic gap regulator is designed in which adaptation to the electromagnet velocity and independence of the regulator dynamics on the magnitudes of the linearization coefficients (K_I,K_δ) are achieved by inclusion of two adaptation modules with controllable respective gain. Calculations are based on theoretical transfer functions of the system components and empirical force-velocity relations. Figures 5; references 1 (Russian).
[21-2415]

UDC [621.315.337.4:537.12.62].012.32/33.001.5

EFFECT OF THERMAL AND MECHANICAL LOADS ON PROPERTIES OF ENAMEL INSULATION ON SUPERCONDUCTOR WIRES

Moscow ELEKTROTEKHNIKA in Russian No 8, Aug 83 (manuscript received 3 Mar 83) pp 45-48

SVALOV, G. G., doctor of technical sciences, FEDOSOVA, S. V., engineer, KOMAROVA, V. N., engineer, and SINYANSKAYA, L. A., engineer, VNIIKP [All-Union Scientific Research Institute of the Cable Industry]

[Abstract] An experimental study was made in order to determine the effect of thermal loads, as well as static and cyclic compression, on the electrical strength of several cryogenic grades of enamel insulation on superconductor wires. A lot of 100 specimens was tested, including PE-943 polyester on copper, PE-955 polyester imide on NT50+copper, UR-9119 polyurethane on copper, PAK-1 polyimide on NT50+copper, AD-9119 polyamide imide on NT50 with KL-1 caprone on copper, all insulation 0.04 mm thick (except 0.03 mm thick PAK-1 on NT50). Tests were performed on straight specimens with two plane-parallel brass electrodes tightly adjoining the specimen surfaces under load and with a knife for cutting the insulation and "grounding" the conductor core. The electrical strength was defined and measured in terms of a.c. voltage at 50 Hz frequency. Thermal shocks were applied in 293(room)-77.4(liquid nitrogen)-293 K and 293(room)-77.4(liquid nitrogen)-4.2(liquid helium)-293 K cycles. The results reveal that thermal shocks degrade the electrical strength of these insulation materials, most of the degradation occurring within theffirst 500 cycles. Although 293-77.4-293 K shocks can be made as severe as 293-77.4-4.2-293 K shocks, they are not as reliable in terms of indicating the electrical strength. The breakdown voltage was also found to decrease under static and cyclic compression in liquid nitrogen. Figures 4; references 3: 2 Russian, 1 Western.
[9-2415]

UDC [621.315.21:537.12.62].017.001.5

STUDY OF ENERGY LOSSES ON MODELS OF SUPERCONDUCTING FLEXIBLE RIBBON CABLES

Moscow ELEKTROTEKHNIKA in Russian No 8, Aug 83 (manuscript received 3 Mar 83) pp 48-50

DOLGOSHEYEV, P. I., engineer, SYTNIKOV, V. Ye., candidate of technical sciences, and POLYAKOVA, N. V., engineer, VNIIKP [All-Union Scientific Research Institute of the Cable Industry]

[Abstract] A method is proposed for measuring the power losses in superconducting cables and separating those in the superconductor from those in the stabilizing normal metal. The method is based on testing a small model which simulates the conditions in a real cable. The model consists of a pair of ribbons wound bifilarly on a bobbin with a thin-film insulation layer between them. Each ribbon is a superconductor covered with a normal metal on one side and each wrapped with insulation tape so as to prevent extraneous losses. The bobbin is made of an insulating material, with holes for passing liquid helium. The structure is designed to eliminate any uncompensated axial magnetic flux and edge effects. The model is palced in a calorimeter so that the beginning and the end of the four-layer helix are brought out. Four schemes of electrical connection are possible, with respectively different numbers of superconductor surfaces and normal-metal surfaces in the magnetic field. The ribbon dimensions are designed, with the aid of a computer, to ensure a magnetic field distribution most favorable to measurement and evaluation of losses. The method was tested on two specimens of such a model, both 42 μm thick Nb_3Sn-Nb+1.5%Zn-Nb_3Sn and 100 μm thick copper but each produced under different thermal conditions. Copper and superconductor were joined through a 3 μm thick layer of POS-60 silver solder in the first specimen and through a 25 μm thick layer of indium solder in the second specimen. Power losses were measured and then separated, the results agreeing very closely with calculations. The results reveal that most power is lost in the normal metal and very little in the solder. Power losses in the normal metal must be reduced, if the total power losses are not to exceed the maximum allowable 17-25 $\mu W/cm^2$ at 4.7 K. Figures 3; references 6: 1 Russian, 5 Western.
[9-2415]

UDC [621.315.212.1:537.312.62].001.5

CURRENT DISTRIBUTION BETWEEN LAYERS IN MULTICONDUCTOR WIRES OF SUPERCONDUCTING ELECTRICAL TRANSMISSION LINE

Moscow ELEKTROTEKHNIKA in Russian No 8, Aug 83
(manuscript received 3 Mar 83) pp 50-52

SYTNIKOV, V. Ye., candidate of technical sciences, SVALOV, G. G., doctor of technical sciences, and DOLGOSHEYEV, P. I., engineer, VNIIKP [All-Union Scientific Research Institute of the Cable Industry]

[Abstract] A general theory is constructed for calculating the current distribution in twisted multiconductor wires of superconducting transmission lines, a theory which can be and has been verified experimentally on physical models of such a line. The theory is based on the second Maxwell field equation in integral form, the integration contour running along the electrically neutral lines in any two wires of adjacent layers and intersecting the matrix where these two wires lie on the same radius. The integration surface is selected to consist of two cylindrical and two plane segments, +1 corresponding to the same direction of twist and -1 corresponding to opposite directions of twist. The resulting expressions for the current ratios have been applied to 2-, 3-, 4-layer superconducting wires with full compensation of the axial magnetic field of the outermost conductor. They have also been verified experimentally on 2- and 3-layer superconducting wires. The agreement is particularly close for 2-layer wires, the current distribution being more uniform in the case of opposite twists and the current ratio I_1/I_2 then being approximately inversely proportional to the tangent squared of the twist angle of the outer layer. In a 3-layer superconducting wire the current distribution is much more uniform, some improvement being achieved by twisting the two inner layers in the same direction and the outer layer in the opposite one. Figures 5; tables 1; references 1 (Western). [9-2415]

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